BRITISH COLUMBIA ENERGY SUPPLY AND REQUIREMENTS FORECAST

1984—2005

Ministry of
Energy, Mines and
Petroleum Resources
Hon. Jack Davis, Minister

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BRITISH COLUMBIA
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Table of Contents

		Page
	LIST OF TABLES	(iv)
	LIST OF FIGURES	(viii)
	HIGHLIGHTS	(xi)
CHAPTER 1:	EXECUTIVE SUMMARY	1
	1.1 Overview	2
	1.2 Summary	4
	1.3 Sectoral Summary	8
	1.4 Petrochemical Feedstocks	22
	1.5 Fuels Summary	22
CHAPTER 2:	EXOGENOUS ASSUMPTIONS	31
	2.0 Introduction	31
	2.1 Economic and Demographic Variables	31
	2.2 Energy Prices	43
CHAPTER 3:	RESIDENTIAL SECTOR	55
	3.0 Introduction	55
	3.1 Historical Profile	55
	3.2 Forecast Methodology and Assumptions	59
	3.3 Energy and Fuel Requirements Forecast	63
CHAPTER 4:	COMMERCIAL SECTOR	73
	4.0 Introduction	73
	4.1 Historical Profile	74
	4.2 Forecast Period Assumptions	78
	4.3 Requirements Forecast	80

CHAPTER 5: INDUSTRIAL SECTOR 89
5.0 Industrial Sector Overview 89
5.1 Forestry 97
5.2 Primary Metals 118
5.3 Chemicals. 121
5.4 Non-Metallic Minerals 125
5.5 Petroleum Refineries 131
5.6 Petrochemicals 134
5.7 Other Manufacturing 139
5.8 Mining 143
5.9 Other Industrial 151
CHAPTER 6: TRANSPORTATION SECTOR 155
6.0 Summary. 155
6.1 Introduction 158
6.2 Road 162
6.3 Rail 172
6.4 Marine 176
6.5 Air 180
CHAPTER 7: NON-ENERGY USE. 185
7.0 Introduction 185
7.1 Historical Perspective 185
7.2 Forecast Period Assumptions. . . . 186
7.3 Requirements Forecast. 187
CHAPTER 8: TOTAL ENERGY REQUIREMENTS 191
8.0 Introduction 191
8.1 Total End-Use Energy Requirements. 191

8.2 Requirements for Energy Supply Industries 204

8.3 Primary Energy Requirements. . . . 209

8.4 Primary Fuel Requirements. 211

CHAPTER 9: CONVENTIONAL ENERGY SUPPLIES. 213

9.0 Introduction 213

9.1 Electricity. 214

9.2 Marketable Natural Gas 217

9.3 Crude Oil From Domestic Producers. 220

9.4 Heavy Fuel Oil 221

9.5 Hog Fuel 224

CHAPTER 10: SUPPLY/REQUIREMENTS BALANCE 227

10.0 Introduction 227

10.1 Electricity. 227

10.2 Natural Gas. 233

10.3 Total Liquid Hydrocarbons. 236

10.4 Heavy Fuel Oil 240

10.5 Hog Fuel 243

List of Tables

Table		Page
	Energy Conversion Factors	(x)
1.1	Forecast of Total End Use Energy Requirements by Fuel Type	6
1.2	Residential Sector Energy Requirements	10
1.3	Commercial Sector Energy Requirements	13
1.4	Industrial Sector Energy Requirements	17
1.5	Transportation Sector Energy Requirements	20
1.6	Provincial Electricity Supply/Demand Balance	23
1.7	B.C. Hydro System Supply/Demand Balance	25
1.8	Marketable Natural Gas Supply/Demand Balance	26
1.9	Liquid Hydrocarbon Supply/Demand Balance	28
1.10	Hog Fuel Supply/Demand Balance	29
2.1	Computation of British Columbia Gross Domestic Product	38
2.2	Forecast of GDP by Sector	40
2.3	Crude Oil Prices	47
2.4	Refined Petroleum Product Prices	48
2.5	Average Natural Gas Prices	51
2.6	Average Electricity Prices	53
3.1	Heating Fuel Efficiency Factors	63
3.2	Mainland Residential Sector Energy Requirements	64
3.3	Vancouver Island Residential Sector Energy Requirements	68
3.4	Provincial Residential Sector Energy Requirements	70

List of Tables
(Continued)

Table		Page
4.1	Real Energy Price Projections: Commercial Sector	78
4.2	Demographic and Economic Projections	79
4.2.1	Details of Commercial GDP Forecast	80
4.3	Provincial Commercial Sector Energy Requirements	81
4.4	Mainland Commercial Sector Energy Requirements	86
4.5	Vancouver Island Commercial Sector Energy Requirements	87
5.0.1	Details of Industrial GDP Forecast	93
5.0.2	Industrial Sector Energy Requirements	95
5.1.1	Forecast of Pulp and Paper Production	104
5.1.2	Forecast of Pulp and Paper Energy Requirements: Province	106
5.1.3	Forecast of Pulp and Paper Energy Requirements: Vancouver Island	110
5.1.4	Forecast of Lumber Production	114
5.1.5	Forecast of Wood Products Industry Energy Requirements	116
5.2.1	Primary Metals Industry Energy Requirements	123
5.3.1	Forecast of Chemicals Industry Energy Requirements	127
5.4.1	Non-Metallic Minerals Sector Energy Requirements	132
5.5.1	Petroleum Refinery Sector Energy Requirements	136
5.6.1	Petrochemical Sector Electricity Requirements	138
5.7.1	Other Manufacturing Sector Energy Requirements	142
5.8.1	Forecast Mineral Production in British Columbia	146

List of Tables
(Continued)

Table		Page
5.8.2	Mining Sector Energy Requirements	149
5.9.1	Other Industrial Sector Energy Requirements	154
6.1	Total Transportation Energy Requirements (by Mode)	156
6.2	Total Transportation Energy Requirements	157
6.2.1	Total Transportation Energy Requirements (Market Shares)	161
6.3	Forecast Input Projections	164
6.4	Passenger Car Fuel Efficiency	165
6.5	New Car Sales and the Stock of Passenger Vehicles	166
6.6	Estimated Vehicle Kilometers Travelled	166
6.7	Road Transport Sector Energy Requirements	167
6.8	Rail Transport Sector Energy Requirements	175
6.9	Real Price Projections	177
6.10	Marine Sector Energy Requirements	179
6.11	Forecast Input Projections	181
6.12	Air Sector Energy Requirements	183
7.1	Forecast of Refined Petroleum Product Requirements for Non-Energy Use	189
7.2	Petrochemical Feedstock Requirements	190
8.1	Provincial (End-Use) Energy Requirements by Sector	192
8.2	Forecast of Total (End-Use) Fuel Requirements	195
8.3	Provincial Electricity Requirements	197
8.4	Provincial Natural Gas Requirements	199
8.5	Forecast of Natural Gas Requirements: Vancouver Island	201

List of Tables
(Continued)

Table		Page
8.6	Refined Petroleum Products (RPP) End Use Energy Requirements by Fuel	202
8.7	Refined Petroleum Products Requirements by Sector	203
8.8	End-Use Energy Requirements for Other Energy Sources	205
8.9	Losses and Fuel Used by Energy Supply Industries	206
8.10	Primary Energy Requirements Forecast	210
8.11	Primary Fuel Requirements	212
9.1	Potential Hydroelectric Supply Options	217
9.2	Maximum Annual Producibility of Marketable Natural Gas	219
9.3	Annual Domestic Crude Oil Producibility	222
9.4	Production of Heavy Fuel Oil by Domestic Refineries	223
9.5	Hog Fuel Supply	226
10.1	Provincial Electricity Supply/Demand Balance	230
10.2	B.C. Hydro System Supply/Demand Balance	232
10.3	Producibility Test	234
10.4	Extended Reserves Test Forecast of Total Surplus	237
10.5	Supply/Demand Balance for Liquid Hydrocarbons (10^3M^3)	238
10.6	Supply/Demand Balance for Liquid Hydrocarbons (Petajoules)	239
10.7	Supply/Demand Balance for Heavy Fuel Oil (10^3M^3)	241
10.8	Supply/Demand Balance for Heavy Fuel Oil (Petajoules)	242
10.9	Hog Fuel Supply and Demand Balance	244

List of Figures

Figure		Page
2.1	Real GNP Growth (U.S.A and Japan)	32
2.2	Real GDP/GNP Growth (Canada and British Columbia)	33
2.3	Interest Rates (U.S.A. and Canada)	35
2.4	Inflation Rates (Vancouver and U.S.A.)	36
2.5	British Columbia G.D.P. by Sector	42
3.1	Historical Energy Use Trends: Residential Sector	56
3.2	Residential Energy Shares (1962 and 1984)	58
3.3	Energy Use Per Household	57
3.4	Relative Fuel Prices: Residential Sector	61
3.5	Mainland Energy Demand: Residential Sector	66
3.6	Vancouver Island Energy Demand: Residential Sector	67
3.7	Provincial Energy Demand: Residential Sector	71
3.8	Residential Energy Requirements	72
4.1	Total Provincial G.D.P.	75
4.2	Commercial Energy Demand	77
4.3	Real Energy Price Projections (Commercial Sector)	78
4.4	Commercial Energy Demand	83
5.0.1	Components of GDP: Industrial Sector	90
5.0.2	Sectoral Composition of Industrial, Total Energy Consumption	91
5.1.1	Pulp and Paper 1984 Energy Requirements	100
5.1.2	Historical Lumber Production Profile	112
5.1.3	Historical Energy Requirements	112

List of Figures
(continued)

Figure		Page
5.2.1	Primary Metals Industry Energy Requirements	122
5.3.1	Chemical Industry Energy Requirements	126
5.4.1	Non-Metallic Minerals Energy Requirements	130
5.5.1	Petroleum Refineries Energy Requirements	135
5.7.1	Other Manufacturing Energy Requirements	141
5.8.1	Mining Sector Historical Energy Requirements	144
5.8.2	Mining Sector Energy Requirements	148
5.9.1	Other Industrial Energy Requirements	153
6.1	Transportation Energy Demand (Market Shares)	159
6.2	Transportation Energy Demand	160
6.3	Road Transportation Fuel Demand	168
6.4	Road Transportation Energy Demand	170
6.5	Annual On-Road Fuel Consumption	171
6.6	Rail Transportation Fuel Demand	174
6.7	Marine Transportation Fuel Demand	178
6.8	Air Transportation Fuel Demand	182
7.1	Non-Energy Use Energy Requirements	188
8.1	(End Use) Energy Requirement by Sector	193
8.2	(End Use) Energy Requirement	196
9.1	Provincial Electricity Capability	215
10.1	Total Provincial Electricity Supply Demand Balance	229
10.2	B.C. Hydro System Electricity Supply Demand Balance	231

Energy Conversion Factors

Fuel Type	Conversion Factors
Coal	1 kilotonne = 29.53 terajoules
Coke	1 kilotonne = 28.83 terajoules
Petroleum Coke	1 megalitre = 42.38 terajoules
Coke Oven Gas	1 gigalitre = 18.61 terajoules
Natural Gas	1 gigalitre = 38.35 terajoules
Crude Oil	1 megalitre = 38.51 terajoules
Motor Gasoline	1 megalitre = 34.66 terajoules
Diesel Fuel Oil	1 megalitre = 38.67 terajoules
Light Fuel Oil	1 megalitre = 38.67 terajoules
Heavy Fuel Oil	1 megalitre = 41.73 terajoules
Aviation Gasoline	1 megalitre = 33.52 terajoules
Aviation Turbo Fuel	1 megalitre = 35.93 terajoules
Kerosene/Stove Oil	1 megalitre = 37.68 terajoules
Still Gas	1 megalitre = 41.73 terajoules
Gas Plant LPG's	1 megalitre = 27.18 terajoules
Refinary LPG's	1 megalitre = 27.18 terajoules
Propane	1 megalitre = 25.50 terajoules
Butane	1 megalitre = 28.60 terajoules
Hydroelectricity	1 gigawatt hour = 3.60 terajoules
Thermal Electricity	1 gigawatt hour = 3.60 terajoules
Non-Energy Products	1 megalitre = 42.06 terajoules
Hog Fuel	1 megalitre SWE* = 7.69-9.10 terajoules
	(*SWE = Solid Wood Equivalent)
Kilo = 10^3	1 megalitre = 1000 cubic metres
mega = 10^6	1 Btu = 1054.615 joules
giga = 10^9	1 cubic foot of gas = 1030 Btu's
tera = 10^{12}	1 barrel = 0.15891 cubic metres
peta = 10^{15}	1 gallon = 4.54609 litres
	1 cubic foot = 0.02832784 cubic metres

HIGHLIGHTS

- The Energy Supply and Requirements Forecast is a comprehensive review of British Columbia's energy markets.

- The report provides a common database and reference for the discussion of energy policies and options by energy consumers, energy producers, government policy makers and other interest groups.

- The forecast updates previous projections by including the impact of declining world oil prices and federal-provincial agreements on energy markets and prices.

- World oil prices are expected to average $US18/Bbl in 1986 and 1987, to increase at the rate of inflation between 1988 and 1994 and to increase at one percentage point above the rate of inflation thereafter.

- Economic growth in the province is projected to average 3.2 percent per year between 1984 and 2005.

- The population of British Columbia is forecast to increase from 2.9 million in 1984 to 3.8 million in 2005.

- Total end use energy requirements are projected to increase at an average annual rate of 1.9 percent from 784 PJ in 1984 to 1151 PJ in 2005.

- Electricity requirements demonstrate the fastest rate of growth, 2.2 percent per year, increasing from 144 PJ in 1984 to 226 PJ in 2005.

- Natural gas demand is forecast to grow from 167 PJ in 1984 to 237 PJ in 2005 demonstrating an average annual growth rate of 1.7 percent.

- Demand for liquid hydrocarbons is expected to increase from 293 PJ in 1984 to 429 PJ in 2005, an average annual rate of 1.8 percent.

- Consumption of other fuels, principally waste material in the forest products sector, is projected to grow at an average annual rate of 1.7 percent from 180 PJ in 1984 to 259 PJ in 2005.

- New hydroelectric power generating facilities will not be required on the B.C. Hydro system until 1997.

- The province's natural gas supply is sufficient to meet indigenous demand and existing export commitments.

- The province will become increasingly dependent on imported liquid hydrocarbons.

- Hog fuel supplies are sufficient to meet requirements.

CHAPTER 1

EXECUTIVE SUMMARY

1.0 Introduction

The Energy Supply and Requirements Forecast is a comprehensive review of British Columbia's energy markets. The report provides a common database and reference for the discussion of energy policies and options by energy consumers, energy producers, government policy makers and other interest groups.

In 1982, the Ministry switched from an engineering/end use approach to energy demand forecasting to an econometric modelling approach. This switch was undertaken primarily to provide the Ministry with a forecasting and planning model[1] which could be used to test explicitly the sensitivity of energy demand to changes in real energy prices and other variables such as Gross Provincial Product, exchange rates and population growth rates. This is the second[2] such forecast to be published by the Ministry utilizing the energy demand forecasting and planning model.

The report is organized into ten chapters. Chapter 1 is an executive summary. Chapter 2 includes a discussion of key underlying assumptions. The sectoral energy forecasts (residential, commercial, industrial and transport) are then discussed in the next four chapters. Chapter 7 summarizes

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1 Details of this model are provided in another Ministry publication: "The B.C. Energy Demand Forecasting and Planning Model"; Staff Paper, B.C. Ministry of Energy, Mines and Petroleum Resources, March 1983.

2 See also "British Columbia Energy Supply and Requirements Forecast, 1982-2000"; Ministry of Energy, Mines and Petroleum Resources, June 1984.

fuel demand for non-energy applications and Chapter 8 presents the total primary and secondary energy requirements. Next, the conventional fuel supply forecasts are discussed and finally, in Chapter 10 a discussion of energy demand and supply balances is provided.

1.1 Overview

This forecast is influenced by three recent major events, each having a significant impact on the energy sector. These events include:

i) "The Western Accord".
ii) "Agreement on Natural Gas Markets and Prices".
iii) The rapid and large decline in the world price of crude oil.

A brief discussion of these matters follows, with a more detailed discussion contained in Chapter 2.

1.1.1 "The Western Accord"

"The Western Accord" of March 27, 1985 is a comprehensive oil and natural gas agreement among the energy-producing provinces of British Columbia, Alberta and Saskatchewan, and the Government of Canada. The Accord went a long way to replacing the taxation and pricing regime originally introduced under the National Energy Program of 1980. The primary objective of the agreement was to stimulate investment and job creation in the energy sector by introducing a regime of market sensitive pricing for oil and gas within a fiscal regime of taxation based on profits. On June 1, 1985 crude oil price deregulation in Canada became effective.

1.1.2 Agreement on Natural Gas Markets and Prices

The Agreement, signed on October 31, 1985, by the parties to the Accord, provides the framework for total deregulation of natural gas prices for interprovincial sales as of November 1, 1986. For natural gas exports, the Toronto wholesale price floor has been replaced by a regional reference price criterion.

1.1.3 World Oil Prices

At this time there is more uncertainty than ever surrounding the future course of world oil prices. The recent decline has been rapid and large reflecting a variety of inter-related factors which have exerted downward pressure on prices, including:

- excess world supply
- the emergence of non-OPEC supplies of crude oil on world markets - e.g. Mexico and the North Sea
- OPEC sales in excess of quotas
- decoupling of economic growth and oil consumption as a result of real price increases in the 1970's
- the recession of the early 1980's
- the discovery of new large gas reserves increasing interfuel price competition

With respect to the forecasting methodology used to produce this forecast, the world price of crude is a major exogenous variable in determining underlying energy demand and relative fuel prices.

1.2 Summary

Since publication of the Ministry's previous forecast of British Columbia Energy Supply and Requirements in 1984, significant events affecting world economies and energy demands have taken place. Most notably, the rapid acceleration in world oil prices which began in 1979 has abated and recently, oil prices have declined sharply. Expectations regarding future oil prices are varied, although the Ministry anticipates declining real oil and natural gas prices in the long term.

For British Columbia, real economic growth over the long term is tied to increases in productivity and the favourable performance of the export sector. Future exports growth is dependent on the strength of existing B.C. export markets, potential competition in these markets and the ability to capture new export markets for new and existing commodities.

Resource-based sectors and their related manufacturing activities will continue to constitute a major portion of British Columbia's economic output. However, they will be increasingly supplanted by new or expanding industrial sectors such as coal, non-resource based manufacturing, finance, transportation, communications and commercial services as drivers of British Columbia economic growth. Real gross domestic product is projected to grow by an average annual rate of 3.3 percent over the 1984 - 1995 period and 3.2 percent over the entire forecast period (1984-2005).

Underlying this environment of steady economic growth are projections of declining real prices for refined petroleum products (RPP) and natural gas. Electricity prices are expected to increase marginally faster than inflation over the long term.

For the purposes of this forecast, it has been assumed that there will be no electricity rate increase in 1986. Annual increases at the rate of inflation from 1987 to 1991 and real price increases of one percent for the remainder of the outlook period are anticipated.

World oil prices are anticipated to stabilize at U.S. $18/Bbl FOB the North Sea in 1986 and 1987, to increase at the U.S. rate of inflation from 1988 to 1994 and to increase one percent above U.S. inflation to 2005. In real terms, residential light fuel oil prices, for example, are expected to decline approximately 25 percent, from $7.46/GJ in 1984 to $5.57/GJ by 2005.

Natural gas prices are assumed to track oil prices. The ratio of the wholesale price of gas to the Vancouver refinery acquisition cost of crude is assumed to approach 65 percent by the year 2000. Natural gas will continue to be less expensive than electricity and light fuel oil. The residential gas price in 1990 equals 53 percent of the oil price and 39 percent of the electricity price on an efficiency adjusted basis.

In light of the above factors, it is forecast that total provincial end-use energy requirements will increase at an average annual rate of 1.8 percent from 784 PJ in 1984 to 1151 PJ in the year 2005 (Table 1.1). This relatively slow

Table 1.1

Forecast of Total End Use Energy Requirements
by Fuel Type
(petajoules)

Year	Liquid Hydrocarbons[1]	Electricity[2]	Natural Gas[3]	Other[4]	Total
1981(act.)	366	138	157	165	826
1984(act.)	293	144	167	180	784
1985(est.)	307	154	172	204	837
1990	324	167	201	230	922
1995	354	180	223	242	999
2000	396	211	235	250	1092
2005	429	226	237	259	1151
AAR					
1984-1995	1.8	2.1	2.6	2.7	2.2
1995-2005	1.9	2.3	0.6	0.7	1.4
1984-2005	1.8	2.2	1.7	1.7	1.8

1 Includes refined petroleum products and natural gas liquids.

2 Includes self generated and purchased electricity.

3 Excludes natural gas used as a feedstock.

4 Includes hog fuel, waste liquor, coal, other by-products and renewables.

growth implies that the amount of energy required to create one dollar of GDP declines from 54.95 MJ in 1984 to 41.54 MJ by the year 2005. British Columbians will be able to achieve a 94% increase in GDP by using only 47% more energy than is used today.

The energy intensity of GDP had been declining during the 1970's and early 1980's in response to price induced conservation. This decline is expected to accelerate in the forecast period, partly due to continued conservation initiatives but mainly due to a swing in the mix of GDP components away from the slower growing, energy intensive industries such as forestry and pulp and paper towards the more rapidly growing but less energy intensive service sector and general manufacturing industries. A major contribution to the reduction results from improved automobile efficiency as Corporate Average Fuel Economy (CAFE) standards for new cars continue to increase and remain above the fleet average. These savings are especially significant since they are all oil products and reduce British Columbia's dependence on out-of-province supplies.

In terms of major fuel types, the fastest growing fuel is electricity, with an average annual growth rate of 2.2 percent between 1984 and 2005. Consequently, its share of total end-use energy rises from 18.3 percent in 1984 to 19.7 percent by 2005. For the most part this growth occurs in the residential sector, commercial sector, primary metals and other manufacturing industries.

The growth in demand for natural gas is expected to average 1.7 percent annually between 1984 and 2005. Mainland natural gas requirements, however, are anticipated to increase much more slowly, at average annual rates of only

1.1 percent per year, due mainly to slack demand in residential and industrial sectors. By 1990, natural gas demand on Vancouver Island is expected to account for 7.9 percent of all natural gas energy, excluding non-energy uses. After 1990, Island requirements are anticipated to increase at an average annual rate of 4.1 percent to account for 12.1 percent of provincial natural gas demand by 2005. The natural gas share of total end-use energy is expected to fall from 21.3 percent in 1984 to 20.5 percent by 2005.

The supply-demand balances for the major fuel types (natural gas, electricity, liquid hydrocarbons and hog fuel) are outlined in more detail below. In summary, it is anticipated that the next in-service date for a hydroelectric project on the B.C. Hydro system will be 1997.

The province will continue to rely on extra-provincial supplies for over 75 percent of its liquid hydrocarbon requirements. Reduced production of heavy fuel oil from domestic refineries will mean heavy fuel oil imports will be needed to support growth in demand, especially for marine bunkering. Finally, there appear to be opportunities for further expansion of hog fuel utilization.

1.3 Sectoral Summary

1.3.1 Residential Sector

Energy in this sector is required for space and water heating, operation of household appliances, and lighting in single detached and attached housing units, apartments and mobile homes. In 1984, residential energy requirements accounted for 16 percent of total conventional end-use energy used in the province.

During the 20 year period between 1964 and 1984, residential energy requirements grew at an average annual rate of 2.8 percent from approximately 70 PJ to 122 PJ. In contrast, forecast requirements are expected to grow by only 2.2 percent annually until 2005 (Table 1.2). Underlying this turnaround is a downturn in the rate of growth in the housing stock from an average of 3.8 percent annually between 1964 and 1984 to an anticipated 1.8 percent between 1984 and the year 2005. Also, it is anticipated that through the forecast period, multiple dwellings, which are less energy intensive than other forms of housing, will make up a larger proportion of the total housing stock, increasing from 33 percent in 1984 to 39 percent by the year 2005.

The shares of electricity and renewable energy increase at the expense of refined petroleum products (RPP's) and natural gas (see Table 1.2). The swing away from petroleum products towards other fuels during the early eighties is a lagged response to the rapid increases in RPP prices between 1979 and 1982. Throughout the forecast period, the switch to electricity is reinforced by a trend toward multiple housing units where electricity is principally used for both space and water heating. Consequently, the share of electricity increases from 33 percent of total residential energy requirements in 1984 to 35 percent in the year 2005.

In the 1981 to 1984 period, natural gas requirements had increased in response to the rapid increase in RPP prices mentioned above. The assumed commencement of natural gas service to Vancouver Island in 1988 gives rise to a further boost in natural gas requirements. The share of energy provided by natural gas, however, is projected to decline because oil-to-gas conversions in the existing mainland

Table 1.2

Residential Sector Energy Requirements
(petajoules)

Year	Natural Gas	RPP	Electricity	Renewable	Total
1981(act.)	55	27	34	0	116
1984(act.)	63	19	40	0	122
1985(est.)	64	17	40	0	121
1990	79	20	43	1	143
1995	90	20	49	3	162
2000	91	24	57	5	177
2005	92	26	66	8	192
AAR					
1984-1995	3.4	0.3	2.0	--	2.6
1995-2005	0.2	2.8	2.9	4.8	1.7
1984-2005	1.8	1.5	2.4	--	2.2

housing stock are projected to slow in response to an increase in natural gas prices relative to light fuel oil prices.

Renewable energy, which is defined to include wood, solar and wind energy, is expected to gain some measureable acceptance due to high conventional energy prices and new technology which make this option more attractive. By 2005, it is anticipated that 7.7 PJ or 4.0 percent of the total provincial residential energy requirements will be met by renewable energy sources.

1.3.2 Commercial Sector

The commercial sector has been defined to include the following economic activities: finance, insurance and real estate; retail and wholesale trade; transportation and communication services; business services; personal services; and public administration.

Between 1974 and 1984 total commercial sector energy requirements grew at an average annual rate of 11.5 percent. Requirements are forecast to grow at an average rate of 2.8 percent annually between 1984 and 2005. The contribution of the commercial sector to provincial GDP is forecast to grow at an annual average rate of 3.3 percent. An overall reduction in energy intensity of 9.8 percent by 2005 is expected to result due to the effect of price induced conservation in the form of improved building design, more efficient use of lighting, ventilation, air conditioning systems, etc.

In terms of the major energy types, the share of natural gas increases at the expense of RPP's and electricity. Natural

gas requirements are buoyed by the assumed commencement of natural gas service on Vancouver Island in 1988. It is expected that the natural gas share of total commercial energy requirements will increase from 41 percent in 1984 to 45 percent or 64 petajoules by 2005 (Table 1.3).

RPP's and electricity's share of total commercial requirements decline over the forecast period reflecting the relative price advantage natural gas is expected to hold over these fuels and the assumed commencement of natural gas service to Vancouver Island in 1988. By the year 2005, oil's share stands at 19.2 percent, down from 21.0 percent in 1984 and electricity's at 35.7 percent down from 38.0. Over the forecast period, RPP and electricity requirements increase from 17 PJ to 27 PJ and from 30 PJ to 51 PJ, respectively.

1.3.3 Industrial Sector

The industrial sector comprises ten economic components; pulp and paper, wood, primary metals, chemicals, non-metallic minerals, petroleum and coal products, petrochemicals, other manufacturing, mining, and other industrial. Natural gas feedstock requirements have been identified as non-energy demand and therefore are not included in the industrial sector energy consumption forecast.

Total requirements for the industrial sector amounted to 379 PJ in 1984, accounting for approximately 48 percent of the province's total energy requirements. By 2005, it is anticipated that industrial sector requirements will have grown to 521 PJ representing 45 percent of total provincial

Table 1.3

Commercial Sector Energy Requirements
(petajoules)

Year	Natural Gas	RPP	Electricity	Total
1981(act.)	31	19	29	80
1984(act.)	33	17	30	79
1985(est.)	34	17	31	82
1990	46	15	36	98
1995	52	18	40	111
2000	62	26	49	136
2005	64	27	51	142
AAR				
1984-1995	4.4	0.9	2.6	3.1
1995-2005	2.1	4.0	2.4	2.5
1984-2005	3.3	2.4	2.5	2.8

requirements. Most of this growth is centered in the mining and "other manufacturing" sectors.

Of the ten industrial components, the pulp and paper and wood sectors alone consume about 70 percent of the energy used in the industrial sector. Characteristics of the future performance expected for the main energy intensive industries are as follows.

GDP in the forest products sector, the combination of pulp and paper and wood industries, is expected to experience vigorous growth of approximately 5.1 percent per annum from 1984 to 1987 and to reach a point in the late 1990's where growth is constrained by available wood supply. As a result growth in energy requirements over the whole forecast period is low, averaging 1.0 percent per year. Energy requirements are also affected by the use of new technologies and the increased utilization of waste wood - particularly in the interior of the province. Thermo-mechanical and chemi-thermo-mechanical pulp technology reduce energy requirements per unit of output but are more electricity intensive. Energy intensity in this sector is expected to fall in real terms from 0.29 GJ per dollar of GDP in 1984 to 0.24 by 2005.

The primary metals industry is dominated by two large firms, Cominco and Alcan, producing lead/zinc and aluminum respectively. Energy requirements are predominantly for electricity, often provided by company owned generating facilities. The industry is expected to experience very little growth in the short term. Markets and prices are expected to improve in 1987/1988 resulting in an average annual growth rate for the 1984 to 2005 period of 1.8

percent. The forecast assumes expansion of the Cominco zinc smelter in the late 1990's and a new lead smelter on stream in the early 1990's. It is further assumed that Alcan will have an aluminum smelter operational in Vanderhoof by 1999. Two other new smelters, one for ferro-silicon and the other for copper are expected to come on stream by the turn of the century. Energy requirements are forecast to grow at an annual average rate of 2.5 percent with electricity growth of 2.6 percent.

The non-metallic minerals industry is dominated by cement manufacturers. The remainder of the industry comprises glass and miscellaneous non-metallic mineral product manufacturing. There are three cement plants operating in the province, two employing a dry process which is less energy intensive but more electricity intensive than the wet process used by the third plant. Energy requirements growth depends on the level of economic activity in the domestic construction industry and the outlook for exports to U.S. markets. Total energy requirements are forecast to grow at an average annual rate of 3.6 percent from 9.2 PJ in 1984 to 19.3 PJ by 2005. Electricity requirements are anticipated to increase at an average rate of 6.2 percent per annum.

The mining industry in British Columbia comprises a host of open-pit and underground operations producing coal, copper, lead, zinc, molybdenum, gold, silver and other metallic and non-metallic minerals. Large scale coal and copper open-pit operations dominate. The forecast assumes that one new major copper mine will be developed in the mid 1990's and that coal production will increase at an average annual rate of 2.6 percent per year from 1984 to 2005.

Metal mines are relatively energy intensive operations

primarily using electricity and diesel fuel. Coal mines use large quantities of natural gas for coal drying. Requirements for refined petroleum products within this sector, mostly diesel fuel, are forecast to grow at approximately 4.7 percent per year over the forecast period. The use of natural gas is expected to decline over time as refuse coal is introduced for coal drying operations.

Adding the energy requirements of these energy intensive industrial sub-sectors to the requirements of the rest of the industrial grouping results in forecast growth of 1.5 percent per annum between 1984 and 2005 for total industrial energy requirements (see Table 1.4).

The major energy type used in the industrial sector is waste material in the form of hog fuel and pulping liquor which is produced and consumed in the forest products subsector. These waste materials currently account for 47 percent of the total energy consumed in the industrial sector and about 23 percent of all energy consumed in the province. It is expected that requirements for these fuels will grow at an average annual rate of 1.2 percent between 1984 and 2005.

The second and third largest energy forms utilized in the industrial sector are electricity (purchased and self-generated) and natural gas. It is expected that total electricity requirements will grow at an average annual rate of 1.9 percent between 1984 and 2005. Natural gas requirements, on the other hand, are expected to grow at only 0.3 percent per annum. This reflects displacement in the mining and non-metallic minerals sectors by coal, and displacement in the interior forest industry by hog fuel and pulping liquors. Increased requirements arising from the assumed commencement of service to Vancouver Island only

Table 1.4

Industrial Sector Energy Requirements
(petajoules)

Year	Natural Gas	Coke & Coal	RPP's	Hog Fuel & Pulping Liq.	Purchased Elec.	Self-Gen. Elec.	Other	Total
1981(act.)	71	-	61	164	44	31	0	371
1984(act.)	71	3	54	178	47	26	0	379
1985(est.)	73	4	63	200	54	29	0	423
1990	74	16	58	211	57	30	1	447
1995	76	20	66	218	59	30	1	470
2000	77	22	75	221	62	42	1	500
2005	75	23	86	227	62	46	1	520
AAR								
1984-1995	0.6	19.8	1.7	1.8	2.1	1.3	-	2.0
1995-2005	-0.1	1.5	2.7	0.4	0.5	4.4	-	1.0
1984-2005	0.3	10.7	2.2	1.2	1.3	2.8	-	1.5

partly offset the displacement on the mainland.

A decline in heavy fuel oil demand (from 1985 to 2005), resulting from displacement by natural gas on Vancouver Island is masked by strong growth of diesel requirements in the mining industry as both fuels are included under the one category of refined petroleum products (RPP's).

In summary, the forecast for the industrial sector indicates a long term trend away from natural gas and refined petroleum products and towards waste material, electricity and coal. In part this is brought about through a change in industrial structure. The shift away from growth in the forest industry to growth in the metal and mineral resources sub-sectors leads to the utilization of technologies which are less fossil fuel intensive. As well, forecast prices for natural gas and refined petroleum products encourage conversion to other fuel types such as hog fuel, pulping liquors and coal.

1.3.4 Transportation Sector

Transportation sector energy requirements encompass those of the four modes of transportation - road, rail, marine and air. In total, transportation requirements account for about 26 percent of the energy used in the province with virtually all being in the form of refined petroleum products. Among the major fuels are motor gasoline, diesel fuel, aviation turbo fuel, and heavy fuel oil. During the forecast period it is expected that propane, natural gas and electricity will play increasingly larger roles.

Technological adjustments to the dramatic increases in refined petroleum product prices since 1978 are expected to

continue to have a depressing affect on product demand until the early nineties - especially for motor gasoline where requirements grow by an average annual rate of only 0.4 percent between 1984 and 1991.

Among the important factors contributing to static motor gasoline requirements is a trend toward smaller more fuel efficient cars brought on by historical gasoline price trends. In real terms, motor gasoline prices increased at an average annual rate of 8.3 percent between 1978 and 1981; adjustment to these higher prices is not yet complete. As a result, it has been assumed that average fleet fuel efficiency will improve by 3.3 percent per year (1984-2005) such that by 1995 the average new car will use only 51 percent of the fuel per kilometre consumed by its counterpart in 1984.

Table 1.5 indicates that motor gasoline requirements are expected to increase only marginally from 128 PJ in 1984 to 131 PJ in 1990. Requirements begin to increase more quickly through the 1990's, reflecting the growth in the stock of vehicles and the greater number of kilometres travelled per vehicle. Holding this resurgence in check are an increasing fleet fuel efficiency and greater utilization of natural gas and propane as alternative fuels to motor gasoline. By 2005 it is anticipated that propane and natural gas will account for some 3 percent of total road requirements.

Requirements for diesel fuel, which stem from the operation of heavy trucks, automobiles, marine carriers in coastal shipping and railroad locomotives, are expected to experience fairly rapid growth, averaging 2.6 percent per annum between 1984 and 2005. Road requirements accounted for approximately 55 percent of the diesel fuel used in the

Table 1.5

Transportation Sector Energy Requirements
(petajoules)

Year	Natural Gas/ Propane	Heavy Fuel Oil	Diesel Fuel Oil	Motor Gasoline	Aviation[1]	Electricity	Total
1981(act.)	0	30	54	150	26	0.2	260
1984(act.)	2	4	50	128	19	0.2	203
1985(est.)	2	3	50	135	21	0.2	210
1990	5	11	57	131	27	0.4	233
1995	8	12	67	137	31	0.9	255
2000	9	12	77	143	35	1.3	278
2005	10	12	85	152	37	1.3	297
AAR							
1984-1995	13.5	9.8	2.6	0.6	4.6	13.9	2.1
1995-2005	2.1	0.1	2.5	1.0	1.8	4.3	1.5
1984-2005	7.9	5.0	2.6	0.8	3.2	9.2	1.8

[1] Includes aviation gasoline.

transportation sector in 1984 and while growth is expected from this source (1.9 percent per year) it is relatively slow because of the increasing use of alternative fuels and a declining impact of the oil price shocks of the seventies.

Heavy fuel oil in the transportation sector is used exclusively in the marine bunker market. A large volume of business was developed in the past through the capture of an increasing share of fuel sales to international shipping on the west coast. This business was curtailed by a variety of factors including: the availability of cheaper bunker fuel at U.S. ports, increased crude costs, more attractive alternative markets, and lower netbacks for refiners. The demand for marine bunker fuel will grow with expanding exports of grain, coal and other bulk commodities and it has been assumed that netbacks will recover to traditional levels.

It is anticipated that requirements for aviation turbo fuel will recover to pre-recessionary levels by 1986/87. With improved economic growth in the nineties and an increasing demand for air transport, demand will begin to grow at rates similar to those existing in the pre-1981 period.

Electricity is expected to make marginal inroads in the transportation sector during the 1980's and 1990's. In addition to the existing trolley bus system in Vancouver which uses electric motors, allowance has been made for the requirements of the Advanced Light Rapid Transit (ALRT) system which has recently begun service. As well, B.C. Rail operates an electrified branch line between Anzac and Prince George.

1.4 Petrochemical Feedstocks

Feedstocks to the petrochemical industry are treated as non-energy use and as such have not been included in the above summary. Petrochemical natural gas feedstock requirements are forecast to grow from 17 PJ in 1984 to 23 PJ by the year 2005, for an average annual growth rate of 1.4 percent.

1.5 Fuels Summary

1.5.1 Electricity

For the most part, electricity in the province is generated from the hydroelectric facilities of four large producers that include B.C. Hydro, West Kootenay Power and Light (WKPL), Cominco and Alcan. The forestry industry also generates small amounts of electricity - mostly by thermal means and this is largely consumed within the industry. B.C. Hydro is by far the largest supplier of hydro-electricity in the province.

Provincial requirements, as presented in Table 1.6, include not only sales of purchased electricity but also losses in transmission and distribution, utility own-use, and requirements met by self-generated hydro electricity in the industrial sector. Supply figures, on the other hand, include all existing and committed projects under critical water conditions on the B.C. Hydro system as well as firm supply capability from Alcan, Cominco, WKPL and industrial sources.

Table 1.6 indicates, in total, that with requirements growing at an average annual rate of 2.1 percent between

Table 1.6

Provincial Electricity Supply/Demand Balance
(GWh)

Year	Total Provincial Requirements	Total Firm Provincial Supply	Supply/Demand Balance (deficit)
1984(act.)	44,469	57,134	12,665
1985(est.)	47,432	59,099	11,667
1986	49,008	59,099	10,091
1987	49,360	59,099	9,739
1988	49,760	59,099	9,339
1989	50,214	59,099	8,885
1990	51,343	59,099	7,756
1991	51,588	59,249	7,661
1992	52,952	59,249	6,297
1993	53,881	59,249	5,368
1994	54,774	59,249	4,475
1995	55,188	59,249	4,061
1996	56,175	59,249	3,074
1997	57,771	59,249	1,478
1998	59,156	59,564	408
1999	63,432	61,247	(2,185)
2000	64,829	61,740	(3,089)
2001	66,278	61,700	(4,578)
2002	67,187	61,660	(5,527)
2003	67,933	63,080	(4,853)
2004	68,735	63,500	(5,235)
2005	69,476	63,425	(6,051)
AAR			
1984-2005	2.1	0.5	--

1984 and 2005, the province will require new generation facilities some time in 1999. Since it has been assumed that B.C. Hydro will develop all major new grid-connected hydroelectric sites, a similar picture emerges when B.C. Hydro is examined in isolation, indicating 1997 as the possible in-service date for a new generation facility on the B.C. Hydro system (Table 1.7).

1.5.2 Natural Gas

A forecast of the maximum producibility of natural gas from fields in British Columbia combined with firm contracted extra-provincial supplies indicates that total supply is capable of meeting forecast domestic and export requirements on an annual basis until 1999 (Table 1.8). However, based on the "adjusted" producibility,[3] supplies are sufficient to meet forecast domestic and export commitments over the entire forecast period.

The supply forecast is based on an assumption that exploration activity will improve to the extent that gas wells drilled in the province will increase from 50 in 1985 to 100 in 1989, 150 in 1995 and 200 in 2000. The total supply of natural gas to the province (adjusted producibility) is expected to decline, however, from 551 PJ in 1985 to about 540 PJ by 2005, reflecting primarily the decline of contracted extra-provincial supplies.

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3 Refers to the fact that the maximum producibility has been adjusted to account for gas carried over from the earlier period of lower than maximum production.

Table 1.7

B.C. Hydro System Supply/Demand Balance
(GWh)

Year	Requirements[1]	Firm Capability	Supply/Demand Balance (deficit)
1984(act.)	35,018	45,355	10,337
1985(est.)	37,243	47,320	10,077
1986	39,082	47,320	8,238
1987	39,172	47,320	8,148
1988	39,537	47,320	7,783
1989	39,995	47,320	7,325
1990	41,131	47,320	6,189
1991	41,661	47,470	5,809
1992	43,030	47,470	4,440
1993	43,963	47,470	3,507
1994	44,859	47,470	2,611
1995	45,275	47,470	2,195
1996	46,266	47,470	1,204
1997	47,893	47,470	(423)
1998	49,283	47,785	(1,498)
1999	50,676	49,470	(1,206)
2000	52,078	49,960	(2,118)
2001	53,093	49,920	(3,173)
2002	53,781	49,880	(3,901)
2003	54,530	51,300	(3,230)
2004	55,335	51,720	(3,615)
2005	56,079	51,648	(4,431)
AAR			
1984-2005	2.3	0.6	--

1 Includes WKPL deficit, and purchased electricity requirements only.

Table 1.8

Marketable Natural Gas Supply/Demand Balance
(petajoules)

	Maximum Producibility	Total Requirements	Supply/Demand Balance	Adjusted Producibility
1985(act.)	551.62	304.13	247.49	551.62
1986(est.)	555.90	299.10	256.80	565.80
1990	524.11	372.52	151.59	586.41
1995	484.27	418.79	65.48	573.37
2000	430.32	447.82	(17.50)	575.18
2005	391.84	458.77	(66.93)	539.85

1 Includes extra-provincial supplies.

2 Includes forecast of gas export requirements.

1.5.3 Liquid Hydrocarbons

The province is expected to continue to rely heavily on extra-provincial supplies to meet requirements for liquid hydrocarbons (including crude oil and natural gas liquids) as indicated in Table 1.9. Currently, B.C. supplies about 32 percent of its requirements for liquid hydrocarbons. The remainder originates in Alberta. Self-sufficiency is expected to decline to 12 percent by 2005 as the growth in requirements is more than offset by a forecast decline in domestic production.

1.5.4 Hog Fuel

Hog fuel supplies are determined by the volume of bark associated with the forecast of timber production (Table 1.10). The supply of hog fuel is forecast to exceed requirements both at the provincial and regional levels. In the interior, however, supplies are expected to be more than adequate to meet forecast requirements over the entire forecast period and indicate a great potential for displacing natural gas.

Table 1.9

Liquid Hydrocarbon Supply/Demand Balance
(petajoules)

Year	Total Requirements	Total Supply	Supply/Demand Balance (deficit)
1984(act.)	326.7	90.9	(235.8)
1985(est.)	336.7	106.4	(230.2)
1990	359.8	74.4	(285.4)
1995	389.7	63.6	(326.1)
2000	438.2	62.4	(375.7)
2005	474.7	57.5	(417.2)
AAR			
1984-2005	1.8	-2.2	--

Table 1.10

Hog Fuel Supply/Demand Balance
(petajoules)

Year	Total Provincial Requirements	Total Provincial Supplies	Supply/Demand Balance (deficit)
1984(act.)	72	158	87
1985(est.)	79	169	90
1990	88	167	80
1995	90	166	75
2000	91	169	78
2005	94	176	82
AAR			
1984-2005	1.3	0.5	--

CHAPTER 2

EXOGENOUS ASSUMPTIONS

2.0 Introduction

This section presents a brief discussion of the underlying exogenous assumptions which must be specified before an energy demand forecast can be produced. The major sets of exogenous variables are economic, demographic, and energy prices.

The long-term economic projections underlying the energy forecast were prepared under the auspices of the Ministry of Finance in February, 1986. These projections provide a framework for planning based on expectations about long-term growth, rather than an official forecast for budgetary purposes.

2.1 Economic and Demographic Variables

Foreign trade plays a vital role in the B.C. economy. In order to set the external environment in which the B.C. economy will function in the future, assumptions about the economies of B.C.'s major trading partners are necessary. Figure 2.1 presents forecasts of economic growth for the United States and Japan. Figure 2.2 presents forecasts of growth for Canada and British Columbia.

The annual Gross National Product (GNP) growth rate in the U.S. is assumed to reach 3.5 percent by 1987, before dropping off and staying constant at 3 percent from 1988 to 1995. In the longer-term, real economic growth in the U.S. is expected

FIGURE 2.1

REAL GNP GROWTH

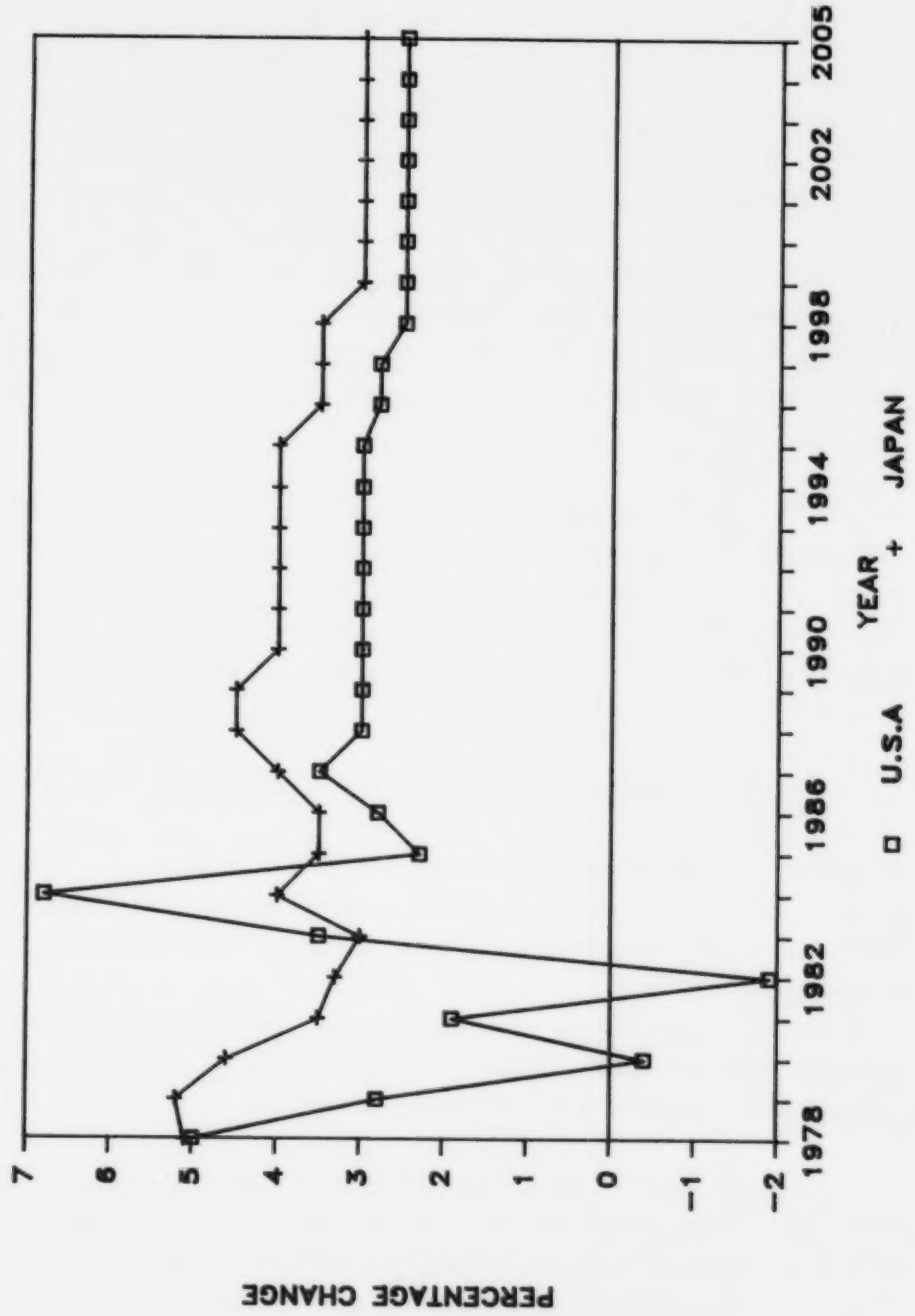
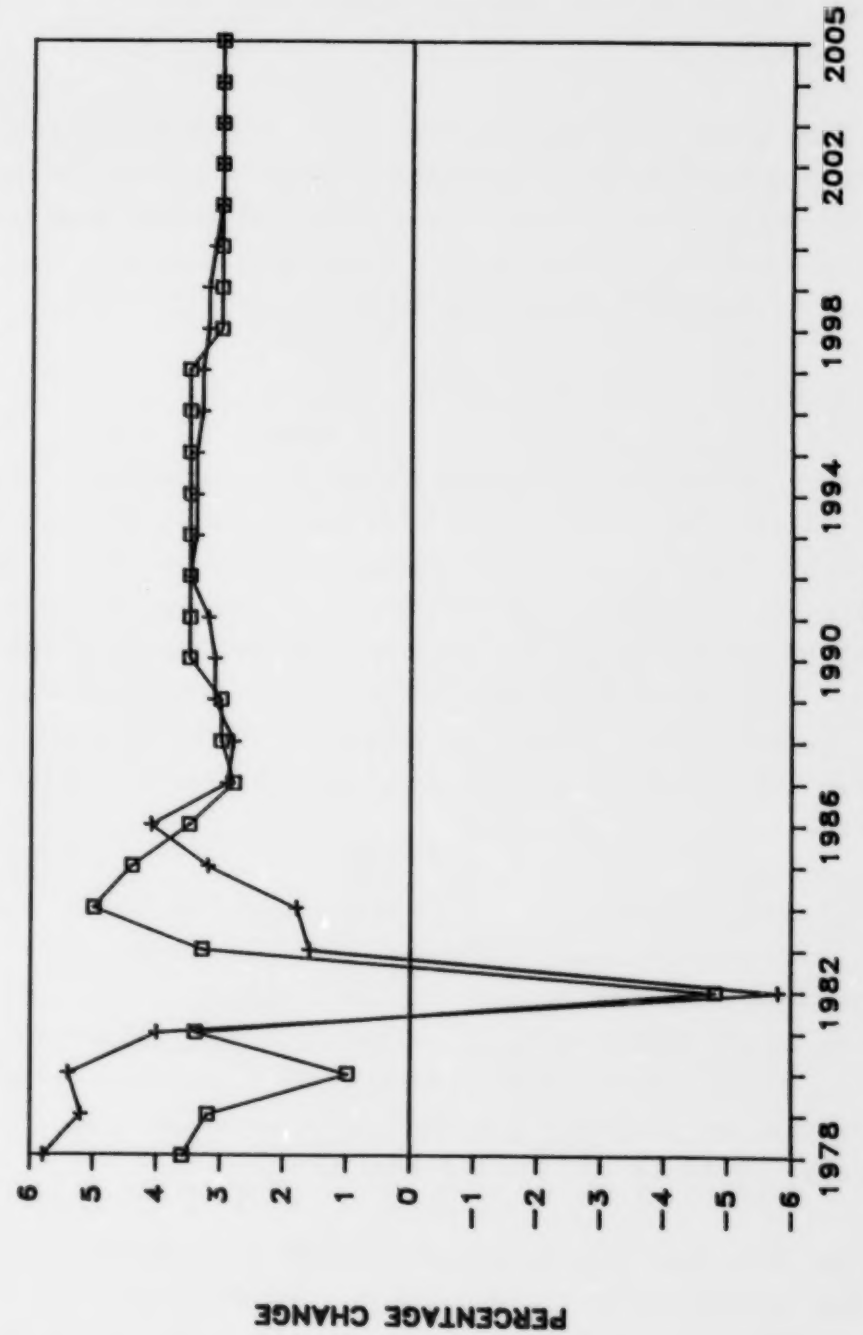


FIGURE 2.2

REAL GDP/GNP GROWTH



to be 2.8 percent in 1996 and 1997, then fall to 2.5 percent from 1998 to 2005.

The economies of Japan and British Columbia's other major trading partners are projected to follow generally the trend in the United States business cycle. However, Japanese real economic growth is expected to continue to exceed that of the United States throughout the forecast period.

Recent events in international financial markets have created a great deal of uncertainty in a number of areas, including currency movements, interest rates and inflation rates. In particular, the so-called G-5 Agreement among the governments of the five largest industrial countries to arrange a significant depreciation of the U.S. dollar has introduced added uncertainty to the picture, especially in the short-term. Furthermore, it is difficult to ascertain what impact the recent OPEC change of course with respect to oil production will have on world financial markets and currencies.

Apart from the broader world uncertainties noted above, it has been assumed that Canadian interest rates will closely track those of the United States (Figure 2.3), yet remain higher in an environment of slightly higher inflation (Figure 2.4). At the same time Canadian real economic growth will fluctuate in response to changing interest rates and the business cycle in the United States.

In the long-run, the Canadian economy is predicted to show a gradually improving trade balance. Favourable terms of trade are expected to strengthen the Canadian dollar from US$.71 in 1986 to US$.73 by 1990 and US$.78 by 1995. Appreciation to US$.85 by the end of the forecast period is assumed.

FIGURE 2.3

INTEREST RATES

(PRIME)

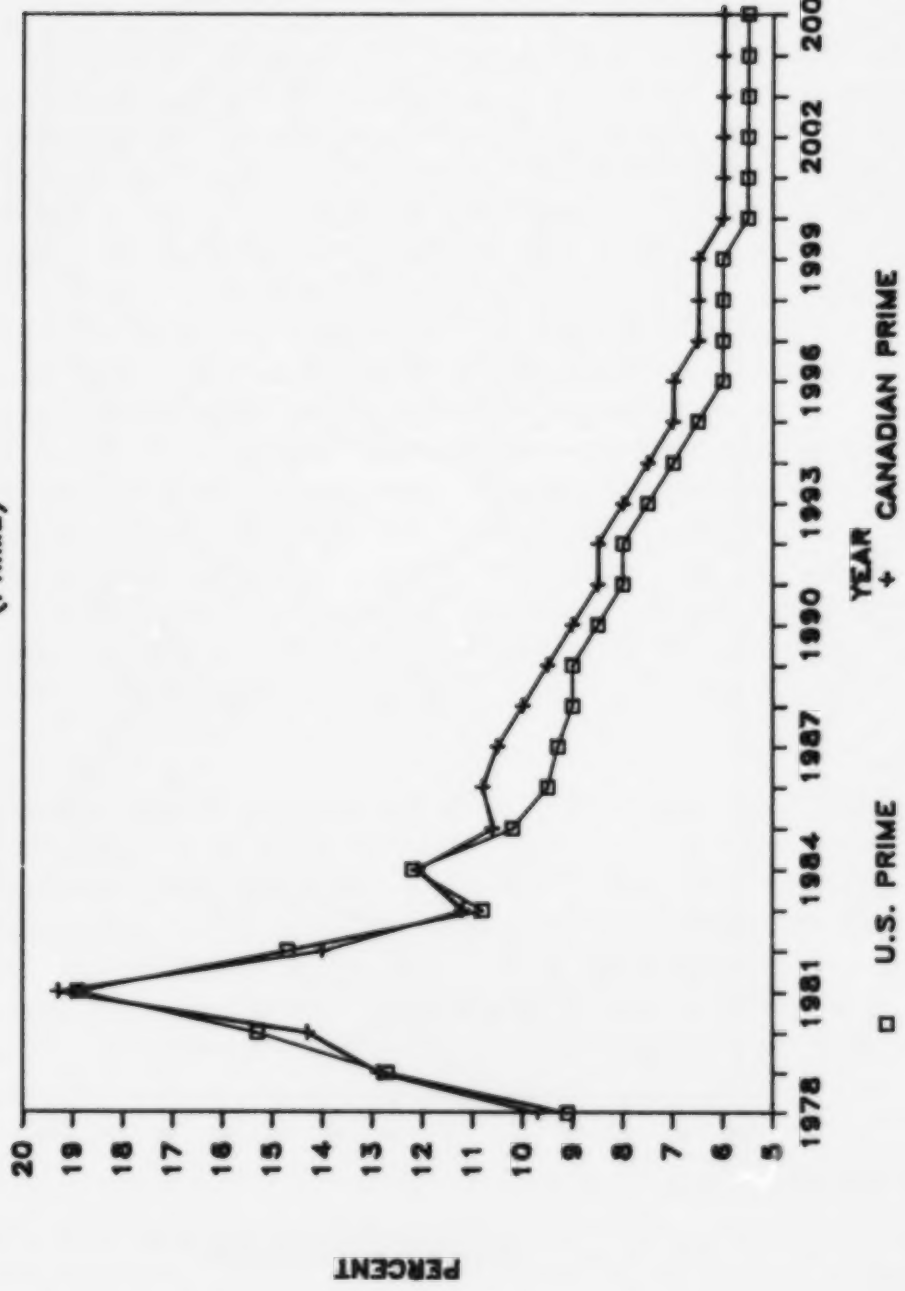
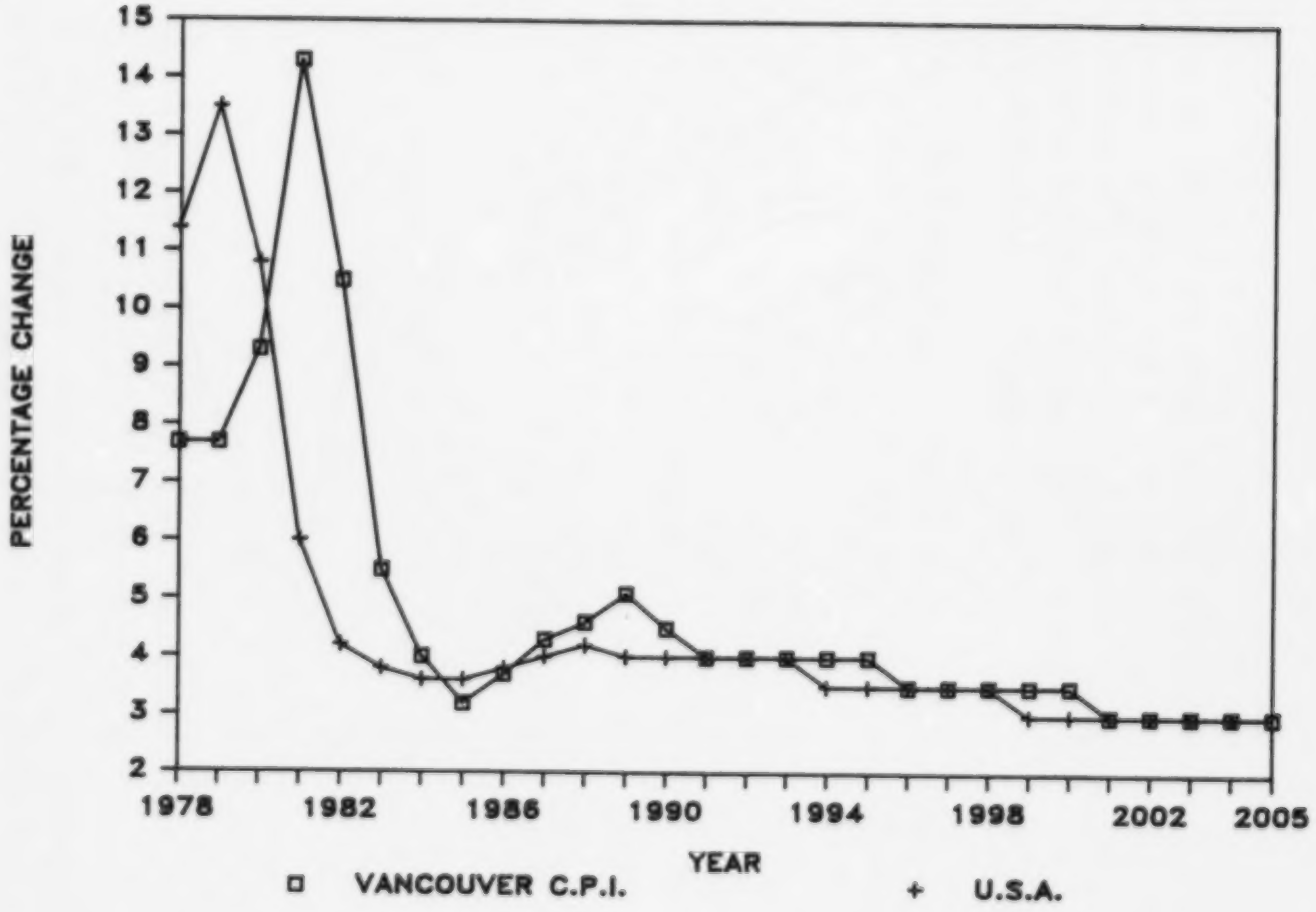


FIGURE 2.4

INFLATION RATES



The labour force is expected to increase throughout the forecast period, from 1.4 million persons in 1984 to approximately 2.1 million by 2005 for an average annual growth rate of 1.9 percent. Table 2.1 summarizes the assumptions regarding the labour force, the unemployment rate, employment, hours worked, productivity and the resulting forecast of Gross Domestic Product (GDP) in B.C.. GDP is calculated by multiplying the employed labour force by the average weekly hours and productivity index.

The unemployment rate is expected to remain higher than its historical standard throughout the 1980's, reflecting constrained employment opportunities associated with slow recovery from the 1982-1984 recessionary period, the forecast cyclical downturn in 1987, and structural changes in the economy, especially in the labour market. However, during the rest of the forecast period the unemployment rate is expected to decline significantly from 8.6 percent in 1991 to 6.2 percent in 2005. This decline reflects a resurgence of employment growth at a rate higher than that of the labour force.

In addition, labour productivity[1] is forecast to increase from $357 in 1984 to $443 by 2005, giving a modest average annual growth rate of 1.0 percent. The major factors contributing to this productivity growth are the expected increase in capital formation, more efficient resource allocation, technological improvements and innovation, a decline in the dependence on high cost energy and greater economies of scale.

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1 Measured as GDP per employee per week.

Table 2.1

Computation of British Columbia Gross Domestic Product

	Labour Force (thousands)	Unemployment Rate (percent)	Employment (thousands)	Work Week (hours)	Productivity (1971 Dollars)	GDP* (millions of) (1971 Dollars)
1983	1388.8	13.8	1196.8	32.8	356.9	14009.0
1984	1409.7	14.7	1201.8	33.2	357.4	14261.0
1985	1431.6	14.2	1228.1	33.0	363.1	14717.0
1986	1454.6	12.7	1270.4	33.2	363.2	15320.0
1987	1477.9	11.6	1306.4	33.2	363.8	15765.0
1988	1501.6	10.7	1340.3	33.1	364.9	16207.0
1989	1527.6	9.9	1375.9	33.1	366.9	16709.0
1990	1550.4	9.3	1406.2	33.0	370.9	17229.9
1991	1573.1	8.6	1437.1	33.0	375.4	17784.6
1992	1601.2	8.1	1471.6	32.9	380.3	18411.3
1993	1630.6	7.8	1504.0	32.8	385.6	19041.6
1994	1661.6	7.5	1537.1	32.8	391.0	19693.5
1995	1695.3	7.3	1570.9	32.7	396.4	20367.8
1996	1729.9	7.2	1605.4	32.6	401.6	21044.3
1997	1763.4	7.0	1640.8	32.6	406.8	21743.3
1998	1798.8	6.8	1676.8	32.5	411.7	22443.3
1999	1836.8	6.7	1713.7	32.4	416.6	23165.9
2000	1875.7	6.6	1751.4	32.4	421.2	23888.1
2001	1915.5	6.6	1790.0	32.3	425.4	24608.4
2002	1956.3	6.5	1829.4	32.3	429.7	25350.5
2003	1997.5	6.4	1869.6	32.2	434.0	26115.0
2004	2039.4	6.3	1910.7	32.1	438.3	26902.5
2005	2082.6	6.2	1952.8	32.1	442.7	27713.8

* Adjusted for residual

Based on a sectoral forecast approach, GDP for the province is expected to grow at an average annual rate of 3.2 percent per year between 1984 and 2005 (Table 2.2).

The primary forestry (logging) sector is projected to increase modestly at an average annual rate of 0.9 percent. However, the share of GDP represented by primary forestry is expected to decline from 2.5 percent in 1984 to 1.6 percent by 2005. This is due to an expected restricted growth in logging during the 1990's as forestry resources become fully utilized. Further, resource contraints are expected to reduce real growth to zero by the turn of the century.

Growth of 2.3 percent per year is expected in the agriculture sector, a rate lower than that of total GDP, primarily due to the physical and economic limitations of British Columbia's agricultural land base. This sector's contribution to GDP is expected to decline slightly from 1.8 percent in 1984 to 1.5 percent by 2005.

The fishing and trapping industry is projected to grow at an average annual rate of 1.0 percent to 2005. As in logging, resource constraints are expected to reduce real growth to zero by the mid 1990's.

In the mining sector, the northeast and northwest coal developments are expected to increase coal production significantly during the 1990's. Coal production is expected to increase more rapidly than any other component of the mining sector which, overall, is projected to increase at an average annual rate of 2.6 percent. Mining's contribution to GDP, however, is expected to decline slightly from 3.5 percent in 1984 to 3.1 percent by 2005.

TABLE 2.2

FORECAST OF GDP BY SECTOR

(MILLIONS OF 1971 DOLLARS)

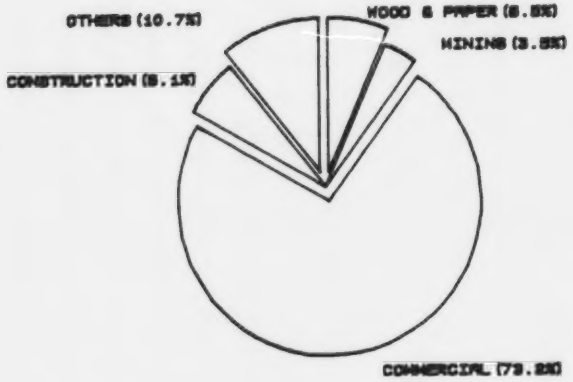
YEAR	AGRICULTURE	FISHING & TRAPPING	PRIMARY FORESTRY	MINING	MANUFACT.	CONST.	UTILITY	COMMERCIAL	RESIDUAL	TOTAL
1981	223	47	358	472	2335	1163	448	9748	-154	14640
1982	240	45	299	394	1976	1009	460	9538	-174	13787
1983	243	69	362	421	2070	976	466	9663	-261	14009
1984	253	52	362	496	2028	869	482	9954	-235	14261
1985	250	54	371	511	2134	885	501	10244	-232	14717
1986	258	54	373	515	2216	921	515	10656	-187	15320
1987	263	54	378	525	2290	980	519	10936	-180	15765
1988	270	57	387	538	2362	1022	523	11244	-194	16207
1989	278	61	401	540	2441	1068	547	11563	-189	16709
1990	286	61	407	554	2517	1116	561	11925	-197	17230
1991	295	62	411	569	2592	1160	575	12327	-206	17785
1992	304	62	415	587	2670	1207	591	12767	-192	18411
1993	313	63	420	606	2750	1255	607	13226	-197	19042
1994	322	64	424	625	2834	1305	625	13700	-204	19694
1995	330	64	428	644	2916	1357	644	14192	-207	20368
1996	338	64	430	664	2989	1405	660	14696	-202	21044
1997	347	64	432	684	3065	1454	676	15220	-199	21743
1998	355	64	434	705	3137	1498	693	15762	-206	22443
1999	364	64	437	727	3210	1543	711	16325	-213	23166
2000	372	64	439	749	3284	1589	728	16880	-217	23888
2001	379	64	439	772	3354	1636	747	17446	-229	24608
2002	387	64	439	793	3427	1686	765	18032	-240	25351
2003	394	64	439	814	3501	1736	784	18637	-254	26115
2004	402	64	439	835	3578	1788	804	19263	-270	26903
2005	410	64	439	857	3657	1842	824	19811	-190	27714
					ANNUAL GROWTH RATES					
1984-1995	2.45	1.97	1.53	2.41	3.36	4.14	2.66	3.28	-1.15	3.29
1995-2005	2.20	.00	.25	2.90	2.29	3.10	2.50	3.39	-.86	3.13
1984-2005	2.33	1.03	.92	2.64	2.85	3.64	2.58	3.33	-1.01	3.21

The manufacturing sector is expected to grow at an average annual rate of 2.8 percent, slightly lower than the rate of growth of total GDP. Economic activity in manufacturing is largely driven by the requirements of resource-based industries such as food processing, wood, pulp and paper, and primary metals. However, due to a movement towards greater diversification in the manufacturing sector, and the impact of new technology, non-resource based manufacturing is expected to become more important. The share of GDP represented by the manufacturing sector is forecast to continue (on a reduced basis) the trend experienced over the last two decades, when its share of GDP declined from about 19.3 percent in 1964 to 14.2 percent in 1984. The share is expected to decline further to 13.2 percent by 2005.

GDP in the construction sector is predicted to grow at 3.6 percent per year between 1984 and 2005. This higher level of residential and non-residential construction investment is necessary to accommodate an expanding economy and population during the 1990's. The share of GDP represented by the construction sector is anticipated to increase from 6.1 percent to 6.6 percent over the forecast period (Figure 2.5).

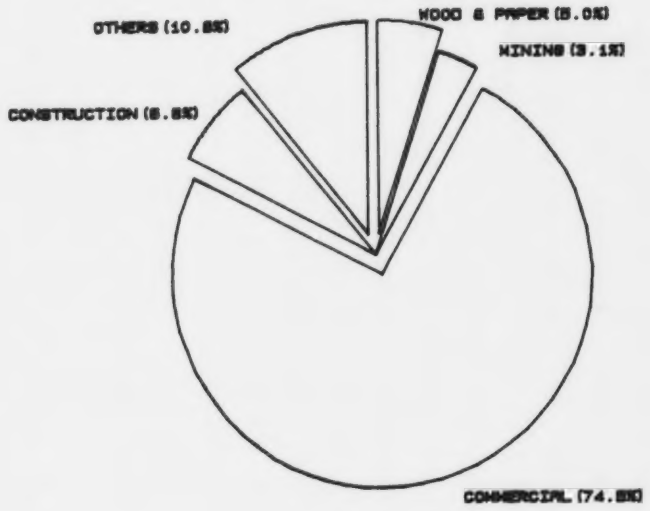
The share of GDP represented by the commercial sector (including utilities), the largest sector in the provincial economy, is expected to increase from 73.2 percent in 1984 to 74.5 percent in 2005. Consequently, the commercial sector is predicted to grow marginally faster than total GDP, at 3.3 percent per year throughout the entire forecast period. This is a result of increased productivity generated by the expanded use of computer and other information processing technologies.

FIGURE 2.5
G.D.P. BY SECTOR
($1971, MILLIONS)



$14261

1984



$27714

2005

The commercial sector consists of a number of subsectors which display different growth patterns. The service subsector is projected to grow most rapidly, at an annual average rate of 3.9 percent over the forecast period. This high growth rate is attributable to the growth in the population base combined with increasing personal disposable income. Further, the wholesale and retail trade subsector is projected to grow by 3.4 percent annually over the forecast period, due to projected falling real interest rates, and steadily rising personal disposable income.

The transportation, communications and storage subsector will maintain its relative long term importance in the B.C. economy and grow by 3.3 percent annually over the forecast period. Technological innovations in this subsector will continue to stimulate growth as they have in the recent past. The three remaining subsectors: finance, insurance and real estate, public administration, and utilities are forecast to grow at average annual rates of 2.8, 2.5 and 2.6 percent respectively.

2.2 Energy Prices

This section outlines the energy price assumptions which underly the sectoral energy forecasts presented in subsequent chapters. The forecast of world oil prices, upon which refined petroleum product (RPP) prices are based is discussed first. This is followed by a discussion of natural gas prices and electricity prices.

2.2.1 World Crude Prices

There is a great deal of uncertainty in world oil markets

today. Some market participants are suggesting that international crude prices will fall to US$5/Bbl while others are suggesting that prices will rise to US$20/Bbl in late 1986. The trend in world oil prices is difficult to predict given the numerous factors which influence the oil market. Moreover, it is unlikely that the timing or magnitude of major dislocations in world supply/demand balances attributable to political instability both within and outside OPEC could be anticipated correctly. Consequently the forecast which follows represents a smoothed projection of the future course of world oil prices.

Oil demand arising from economic growth in 1986 and 1987 will be offset by the impact of major conservation measures taken in Europe and a switch to natural gas, coal and nuclear power. Further, recent increases in OPEC supply will reinforce the downward pressure on prices. At some point, however, higher cost non-OPEC supply is likely to be withdrawn from the market. The Ministry's world oil price forecast anticipates that oil prices, as measured by Brent Crude FOB the North Sea, will fall from US$26.50/Bbl at year end in 1985 to an average of US$18/Bbl in 1986 and 1987.

From 1988 to 1994 as world demand increases in response to world economic growth and the drop in oil prices of 1986 and 1987, crude prices are expected to stabilize and grow at the rate of U.S. inflation. By 1995, it is anticipated that OPEC's influence over world crude prices will enable it to once again increase prices faster than the rate of inflation. However, in light of the experience of the late seventies and early eighties, price increases above the rate of inflation are likely to be held to more modest rates. Consequently,

the Ministry is assuming that world crude prices will increase at only one percent, on average, above the rate of inflation beyond 1995.

2.2.2 Refined Petroleum Product Prices

In March 1985, the governments of Canada and the three western energy producing provinces of Saskatchewan, Alberta and British Columbia reached a comprehensive agreement with respect to oil and natural gas in what is referred to as the Western Accord. The Western Accord encompassed three primary elements - total deregulation of crude oil pricing and marketing, a committment to making natural gas more market responsive and a set of fiscal principles which would serve to stimulate the industry and provide for taxation based on profits rather than on revenue.

Effective June 1, 1985, the Accord provided that the two tiered pricing system of crude oil between old (oil discovered before 1981) and NORP (oil discovered after 1980 including synthetic oil and oil from "Canada Lands") would be abandoned and that all crudes would be priced at world price levels. There was also a provision to allow the free flow of both crude and refined petroleum products into and out of Canada without restraint by the National Energy Board, except for long term exports.

The impact of the Accord on refined petroleum product pricing is that refinery costs for crude (for example as measured by the Vancouver Refinery Acquisition Cost of Crude or VRAC) are no longer based on a "blended price" as set out in the National Energy Program but reflect the international price for crude adjusted for transportation costs. In deriving the

VRAC price upon which refined petroleum product prices in this forecast are based, the Ministry has adopted Brent Crude, priced in U.S. dollars, as an international marker. The appropriate transportation charges and exchange rate adjustments have been added to bring it to Vancouver via the St. James, Texas loop to Chicago and then to Edmonton. Table 2.3 reports the derivation of VRAC prices over the period from 1981 to the year 2005.

RPP prices, with the exception of heavy fuel oil are determined by adding to the VRAC price, which includes the cost of crude consumed in the refinery, refinery margins, distribution margins and relevant taxes for each product. The refinery margins are based on the assumption that refiners would set product margins in order to maintain a minimum revenue flow after the purchase of crude.

Prices for heavy fuel oil have been tied directly to the international cost of crude in recognition of the international trade of this product. Based on the relationship between heavy fuel oil prices and international crude prices over the period from 1978, heavy fuel oil prices in the industrial sector have been set at 80 percent of crude. Further, refinery margins for all other products have been adjusted, on a pro-rata basis, so as to maintain a minimum revenue requirement after the gain or loss on the sale of heavy fuel oil net of taxes.

Table 2.4 reports selected refined petroleum product prices on an annual basis between 1981 and 2005.

Table 2.3

Crude Oil Prices
(Dollars/Barrel)

	EDMONTON PRICE	TMP LEVY	VRAC	(1985$)	REAL GROWTH	FOB BRENT	FOB BRENT (1985$US)
1981	26.92	.59	27.51	34.63	---	29.00	34.14
1982	32.41	.68	33.09	38.55	11.32	29.00	32.66
1983	35.05	.82	35.87	39.08	1.36	29.00	31.20
1984	35.56	.79	36.35	37.83	-3.19	29.00	30.05
1985	36.75	.80	37.55	37.54	-.77	26.81	26.81
1986	27.26	.83	28.09	27.03	-28.00	18.00	17.38
1987	27.15	.86	28.01	25.93	-4.08	18.00	16.75
1988	27.45	1.16	28.61	19.91	-23.22	18.54	16.59
1989	28.35	1.31	29.66	18.08	-9.20	19.31	16.59
1990	29.32	1.37	30.69	17.87	-1.11	20.09	16.59
1991	30.14	1.43	31.56	17.66	-1.23	20.89	16.59
1992	30.93	1.48	32.41	17.43	-1.27	21.73	16.59
1993	31.74	1.54	33.29	17.21	-1.24	22.60	16.59
1994	32.59	1.61	34.19	17.00	-1.23	23.50	16.59
1995	33.54	1.67	35.21	16.83	-.99	24.54	16.72
1996	34.61	1.73	36.34	16.77	-.41	25.65	16.88
1997	35.71	1.78	37.50	16.78	.07	26.81	17.05
1998	36.87	1.84	38.71	16.81	.21	28.03	17.22
1999	38.06	1.89	39.96	16.85	.22	29.30	17.39
2000	39.39	1.95	41.34	16.93	.45	30.52	17.57
2001	40.73	2.01	42.74	16.99	.37	31.75	17.74
2002	42.12	2.07	44.19	17.05	.38	33.02	17.92
2003	43.56	2.13	45.69	17.12	.38	34.36	18.10
2004	45.04	2.19	47.24	17.18	.39	35.74	18.28
2005	46.66	2.26	48.92	17.28	.54	37.18	18.47

TABLE 2.4

REFINED PETROLEUM PRODUCT PRICES

(DOLLARS PER BARRELE)

YEAR	AVIATION TURBO	DIESEL FUEL OIL (NON-ROAD)	HEAVY FUEL OIL (INDUSTRIAL)	LIGHT FUEL OIL (COMMERCIAL)	LIGHT FUEL OIL (RESIDENTIAL)	LIQ. PET. GAS (INDUSTRIAL)	MOTOR GASOLINE (ROAD)
1981	8.170	7.725	3.372	6.710	6.360	7.230	10.327
1982	10.106	9.519	3.641	8.178	7.715	9.272	12.381
1983	11.156	10.495	3.901	9.060	8.513	10.891	13.520
1984	11.973	11.302	4.904	9.680	9.046	11.737	14.418
1985	10.986	10.670	5.054	10.874	9.323	12.096	15.453
1986	10.650	10.477	3.658	9.529	8.170	10.600	14.416
1987	10.436	10.502	3.726	9.278	7.955	10.321	14.531
1988	10.715	10.752	3.902	9.517	8.160	10.587	14.880
1989	11.161	11.163	4.130	9.912	8.499	11.026	15.424
1990	11.586	11.555	4.368	10.289	8.822	11.446	15.940
1991	11.979	11.917	4.481	10.638	9.121	11.834	16.419
1992	12.366	12.272	4.598	10.979	9.413	12.213	16.891
1993	12.768	12.640	4.719	11.332	9.716	12.606	17.380
1994	13.184	13.021	4.844	11.699	10.031	13.014	17.887
1995	13.628	13.428	4.990	12.090	10.366	13.450	18.426
1996	14.077	13.844	5.147	12.491	10.710	13.895	18.966
1997	14.511	14.248	5.309	12.880	11.044	14.329	19.486
1998	14.959	14.665	5.478	13.283	11.389	14.776	20.023
1999	15.423	15.097	5.653	13.700	11.746	15.240	20.577
2000	15.917	15.558	5.849	14.145	12.128	15.735	21.166
2001	16.424	16.031	6.044	14.601	12.519	16.243	21.771
2002	16.948	16.519	6.246	15.073	12.924	16.768	22.395
2003	17.490	17.025	6.455	15.561	13.343	17.311	23.040
2004	18.049	17.547	6.671	16.066	13.775	17.872	23.706
2005	18.646	18.105	6.895	16.605	14.237	18.472	24.415
			ANNUAL GROWTH RATES				
1984-1995	1.18	1.58	.16	2.04	1.25	1.25	2.25
1995-2005	3.18	3.03	3.29	3.22	3.22	3.22	2.85
1984-2005	2.13	2.27	1.64	2.60	2.18	2.18	2.54

2.2.3 Natural Gas Prices

The Western Accord included an agreement to move to more flexible and market oriented pricing in domestic natural gas markets. On October 31, 1985, the "Agreement among the Governments of Canada, Alberta, British Columbia and Saskatchewan on Natural Gas Markets and Prices" was announced.

The main objective of the Agreement was to provide the conditions under which price deregulation of interprovincial sales of natural gas could occur by November 1, 1986. In addition, gas export floor prices were to be based on a comparison to prices in the region adjacent to the export point, rather than to the Toronto city gate price.

Based on recent field prices for direct sales of natural gas and an US$18/Bbl price for world crude in 1986, it is anticipated that the average wholesale price of natural gas will fall from an estimated 60 percent of VRAC at $2.66/GJ to about 50 percent of VRAC over the 1986 to 1988 period. In light of continued weak export markets and a surplus of natural gas, average wholesale prices are anticipated to remain at 50 percent of VRAC through 1990.

Over the longer term, export sales are expected to strengthen. The existing surplus is expected to be reduced with only moderate drilling activity assumed in the late 1980's. Consequently, it is expected that market forces will begin to raise natural gas prices at the burner tip. As this occurs, the average wholesale price of natural gas is assumed to increase from 50 percent of VRAC in 1990 to 55 percent of VRAC in 1995 and eventually 65 percent of VRAC by 2000. For

the purpose of this forecast, the 65 percent relationship in 2000 has been extended through to 2005.

Wholesale prices for each of the three domestic utilities are calculated by applying appropriate differentials to the provincial average wholesale price. These are used as the basis for determining the system gas prices for the various consumer classes. Sectoral natural gas prices are determined by using the consumption patterns of the sector to establish a weighted average gas price. Where appropriate, the average price is calculated for different utilities and aggregated to a single price series. Additionally, allowances were made for some direct sales to industrial customers from gas producers at prices based on currently existing direct sales. These prices are adjusted for transmission costs. Customer class prices are the average of system gas prices and direct sale prices (see Table 2.5).

2.2.4 Electricity Prices

The forecast of electricity prices is based on Special Direction Number One (revised March 14, 1984) which requires B.C. Hydro to achieve an interest coverage ratio of 1.3:1 by fiscal year 1990/91.

Revenue derived from sales under the Industrial Electricity Rate Discount Act (Bill 28) and the Critical Industries Act (Bill 31), and continued sales of electricity into the export market, will allow the target interest coverage ratio to be achieved if electricity prices increase at the rate of inflation between 1987 and 1990.

TABLE 2.5

AVERAGE NATURAL GAS PRICES

(DOLLARS PER GIGAJOULE)

YEAR	AVERAGE WHOLESALE	RESIDENTIAL	COMMERCIAL	INDUSTRIAL			
				PAPER	WOOD	REFINERIES	OTHER MAN.
1981	1.282	3.177	3.065	2.183	2.705	2.249	2.704
1982	1.669	4.145	4.089	2.922	3.467	3.152	3.466
1983	1.897	4.263	4.224	2.967	3.522	3.217	3.521
1984	2.397	4.461	4.441	3.183	3.761	3.440	3.761
1985	2.527	4.546	4.527	3.171	3.786	3.406	3.785
1986	2.611	4.510	4.280	2.974	3.710	3.290	3.710
1987	2.469	4.420	4.160	2.789	3.512	2.964	3.582
1988	2.346	4.370	4.090	2.667	3.415	2.829	3.491
1989	2.348	4.470	4.170	2.682	3.449	2.892	3.538
1990	2.434	4.650	4.340	2.738	3.517	2.958	3.642
1991	2.534	4.830	4.510	2.869	3.677	3.099	3.795
1992	2.638	5.050	4.720	3.010	3.849	3.250	3.972
1993	2.870	5.370	5.020	3.230	4.111	3.490	4.247
1994	2.954	5.550	5.190	3.335	4.246	3.595	4.386
1995	3.098	5.800	5.430	3.493	4.436	3.763	4.583
1996	3.279	6.080	5.700	3.686	4.661	3.966	4.819
1997	3.506	6.400	6.010	3.914	4.931	4.214	5.104
1998	3.746	6.740	6.340	4.160	5.239	4.480	5.398
1999	3.996	7.090	6.680	4.415	5.497	4.755	5.701
2000	4.263	7.470	7.040	4.698	5.813	5.048	6.025
2001	4.488	7.800	7.360	4.927	6.083	5.297	6.309
2002	4.638	8.050	7.600	5.094	6.282	5.474	6.526
2003	4.796	8.310	7.850	5.270	6.489	5.650	6.733
2004	4.960	8.580	8.110	5.446	6.697	5.846	6.959
2005	5.132	8.870	8.380	5.632	6.923	6.042	7.195
			ANNUAL GROWTH RATES				
1984-1995	2.36	2.41	1.84	.85	1.51	.82	1.81
1995-2005	5.18	4.34	4.43	4.89	4.55	4.85	4.61
1984-2005	3.69	3.33	3.07	2.75	2.95	2.72	3.14

After 1990, electricity prices have been assumed to increase at an annual rate of one percentage point above the rate of inflation based on the general principle of pricing energy commodities to reflect long run replacement costs. While these rates of increase are not expected to achieve long run replacement cost within the time frame of this forecast, they do move prices closer to that goal. Further, smooth electricity price increases have been assumed in order to avoid an otherwise inevitable cycle of declining real prices, when no new generation projects are required, followed by steeply rising real prices in the face of bringing new generation projects on stream.

Electricity prices in all sectors have been escalated at the same rates and are reported in Table 2.6.

TABLE 2.6

AVERAGE ELECTRICITY PRICES

(1985 DOLLARS PER GIGAJOULE)

YEAR	RESIDENTIAL	COMMERCIAL	INDUSTRIAL			
			PAPER	WOOD	REFINERIES	OTHER MAN.
1981	13.811	12.470	6.991	10.958	6.760	10.811
1982	14.499	13.366	8.059	11.729	7.841	11.736
1983	14.776	13.627	8.361	11.937	8.155	11.958
1984	15.319	14.188	8.757	12.446	8.545	12.469
1985	15.399	14.265	8.804	12.518	8.591	12.542
1986	14.853	13.759	8.492	12.074	8.287	12.098
1987	14.852	13.758	8.491	12.073	8.286	12.097
1988	14.845	13.751	8.487	12.067	8.282	12.091
1989	14.847	13.754	8.488	12.069	8.283	12.092
1990	14.847	13.753	8.488	12.069	8.283	12.093
1991	14.998	13.893	8.574	12.192	8.367	12.215
1992	15.145	14.029	8.658	12.312	8.449	12.336
1993	15.299	14.173	8.747	12.437	8.536	12.461
1994	15.453	14.314	8.834	12.561	8.621	12.585
1995	15.605	14.456	8.921	12.685	8.706	12.710
1996	15.763	14.602	9.012	12.814	8.795	12.839
1997	15.919	14.747	9.101	12.941	8.881	12.965
1998	16.083	14.898	9.195	13.074	8.972	13.099
1999	16.239	15.043	9.284	13.200	9.059	13.226
2000	16.403	15.194	9.377	13.334	9.151	13.359
2001	16.568	15.348	9.472	13.468	9.243	13.494
2002	16.734	15.502	9.567	13.603	9.336	13.630
2003	16.896	15.652	9.660	13.735	9.426	13.761
2004	17.066	15.810	9.757	13.873	9.522	13.900
2005	17.240	15.971	9.857	14.015	9.619	14.042
			ANNUAL GROWTH RATES			
1984-1995	.17	.17	.17	.17	.17	.17
1995-2005	1.00	1.00	1.00	1.00	1.00	1.00
1984-2005	.56	.57	.57	.57	.57	.57

CHAPTER 3

RESIDENTIAL SECTOR

3.0 Introduction

Residential energy use refers to energy consumed in single detached, single attached, apartment and mobile housing units for space heating, water heating, appliances and lighting applications. In addition, it includes energy used for heating private swimming pools and diesel fuel oil consumption in the agriculture sector. Energy in this sector is principally used in the form of natural gas, electricity and light fuel oil; however, some remote areas of the province rely heavily on wood and LPG's for cooking and heating applications.

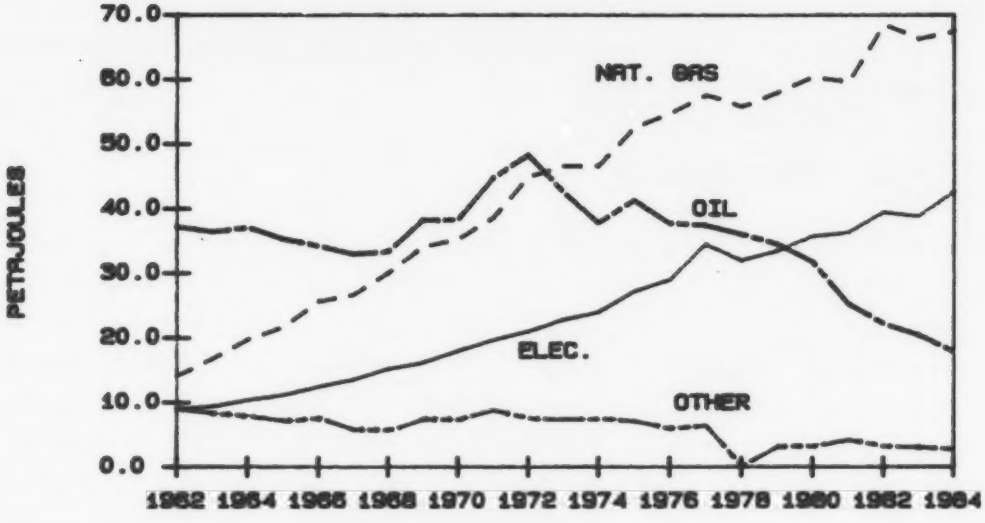
3.1 Historical Profile

Currently, the residential sector accounts for an estimated 20.0 percent of the total energy consumed from conventional sources in British Columbia compared to 23.0 percent in the early 1960's. This decline in its share is largely due to energy conservation measures caused by high fuel prices and federal and provincial policies of the late 1970's and the early 1980's.

In the 1960's and early 1970's, energy demand in the residential sector grew at a rate of about 5.8 percent per year. However, following the oil price shock in 1973, the growth moderated to 0.6 percent per year. Figure 3.1 which presents historical trends of various fuels used in the residential sector indicates robust growth for both natural gas and electricity. Natural gas demand demonstrated the

highest rate of growth, averaging 7.4 percent per year over the 1962-1984 period. Over the same period, electricity demand grew at an average rate of 7.3 percent per year. The consumption of RPPs declined in the period following the disruption in world oil supplies, from 40.0 petajoules in 1973 to 16.7 petajoules in 1984. The use of "other" fuels[1] also dropped from 8.3 petajoules in 1962 to about 2.5 petajoules in 1984.

FIGURE 3.1
HISTORICAL ENERGY USE TRENDS
RESIDENTIAL SECTOR



This divergence in the growth rates among competing fuels significantly affected the market shares held by various fuels. In 1962, for example, oil was the principal fuel supplying over 54.0 percent of residential energy; in 1984 it supplied only 13.7 percent of residential requirements.

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1 The "other" fuels category is defined to include coal and coke, LPG's and renewable energy forms.

On the other hand, both natural gas and electricity signficantly expanded their market shares. Natural gas' share increased from 20.0 percent in 1962 to 51.6 percent in 1984 and electricity's share jumped from 13.0 percent to 32.7 percent over the same period. The share of "other" fuels declined from 13.0 percent in 1962 to 2.0 percent in 1984 (Figure 3.2).

Energy use per household in British Columbia also changed significantly over the historical period. Prior to the oil price shock, energy use per household displayed an increasing trend from 129.0 gigajoules per household in 1962 to 161.0 gigajoules per household in 1973 (Figure 3.3). However, in the post-1973 period, it declined sharply in response to energy price increases. This decline in energy use per household was the key factor contributing to the decline in the growth rate of residential energy demand.

FIGURE 3.3
ENERGY USE PER HOUSEHOLD

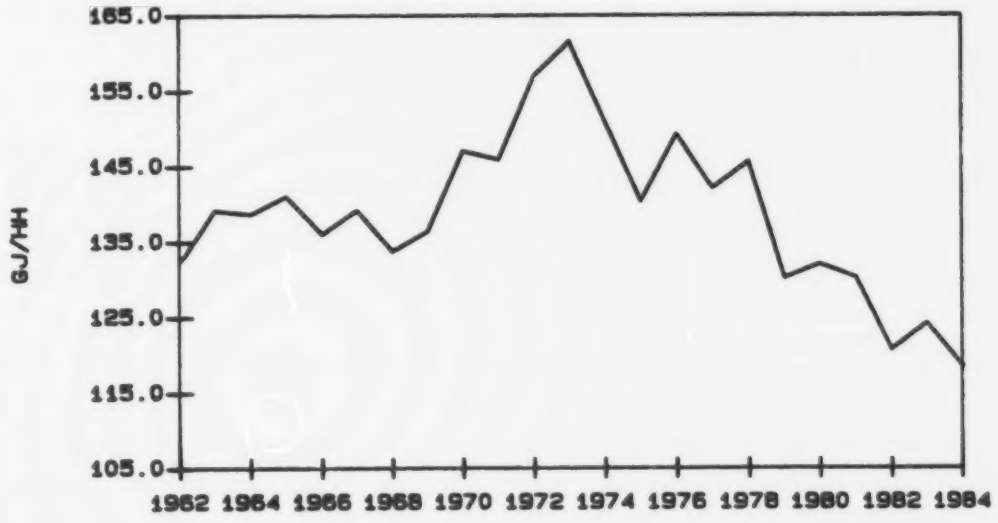
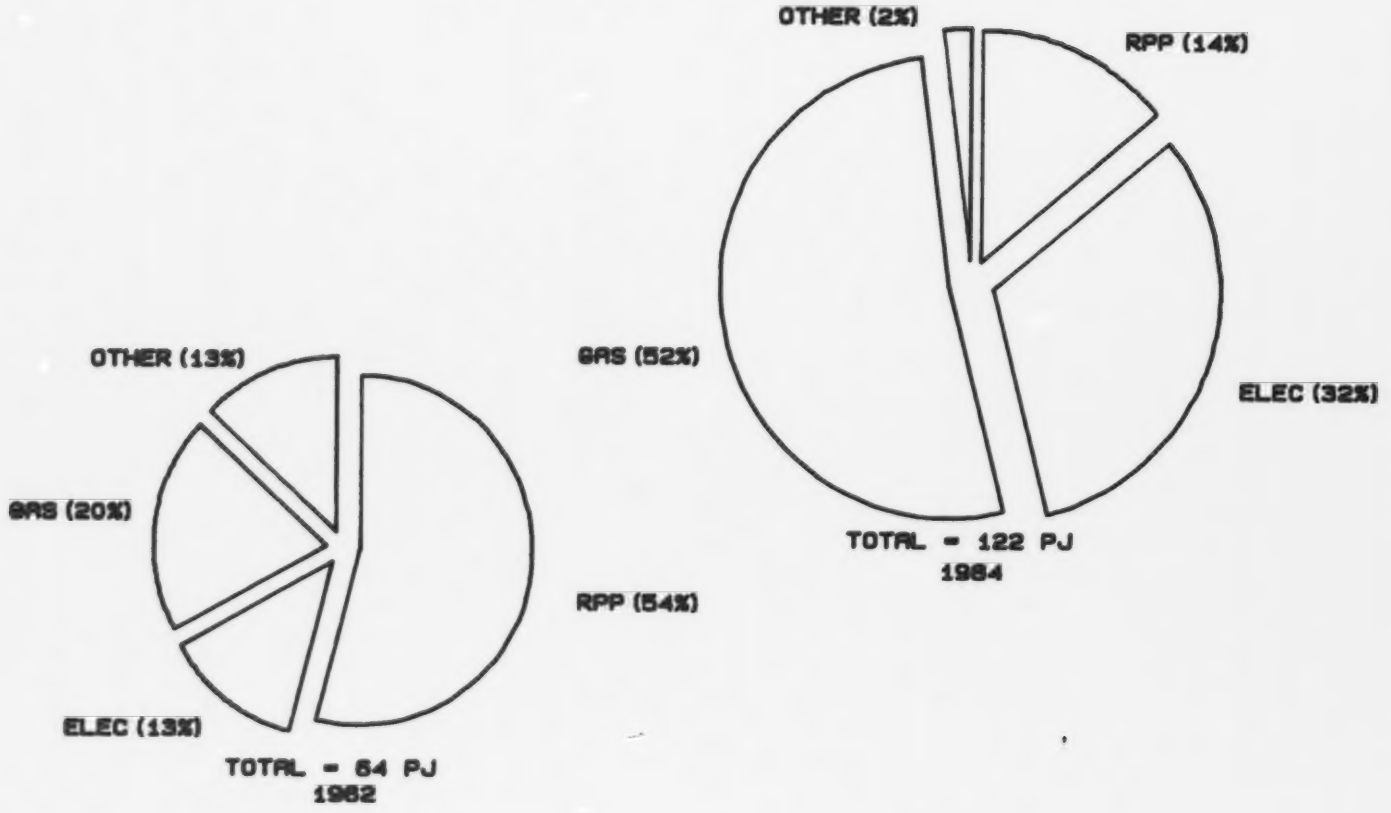


FIGURE 3.2
RESIDENTIAL ENERGY SHARES
(1962 - 1984)



Currently, an average household in British Columbia consumes about 115 to 120 gigajoules of energy per year of which approximately 61.0 percent is consumed for space heating, 18.0 percent for water heating and about 21.0 percent for lighting and appliances.

3.2 Forecast Methodology and Assumptions

Residential energy requirements (excluding demand for diesel fuel oil) are determined separately for the Mainland and Vancouver Island. Energy requirements for both of these regions are estimated by relating energy demand per household to energy prices, real disposable income per household, and degree days. Individual fuel demands are derived by applying market shares, which are dependent on relative fuel prices and the multiple/non-multiple housing mix, to total energy.

The market shares for the Mainland are estimated for natural gas, electricity and oil; for Vancouver Island, however, only oil and electricity shares were forecast. Natural gas requirements for Vancouver Island are estimated on the expected level of oil and electricity displacement resulting from the extension of natural gas service.

Diesel fuel oil requirements are determined for the province as a whole based on economic activity in the agriculture sector and the price of diesel oil.

3.2.1 Economic and Demographic Assumptions

As reported in Chapter 2, British Columbia's population is assumed to increase from 2.863 million in 1984 to 3.825

million by 2005 - an average annual growth rate of 1.4 percent. Approximately 34.0 percent of this growth is expected to be from natural causes. The remaining 64 percent is attributable to net migration. Over the short-term, international and interprovincial migration is expected to be significantly lower than historical levels; however, by the mid 1990's in-migration is expected to rebound to its long term historical average of about 30,000 per year.

The number of households is forecast to grow at 1.8 percent per year - a rate slightly higher than the rate at which population is expected to grow reflecting the effect of an escalating divorce rate and declining household size. Over the forecast period a significant shift in the housing mix is expected. Multiple units which currently account for about 33.1 percent of the housing stock are projected to increase to 38.9 percent by 2005.

Real disposable income per household is assumed to grow at a rate of 1.5 percent per year between 1984 and 2005.

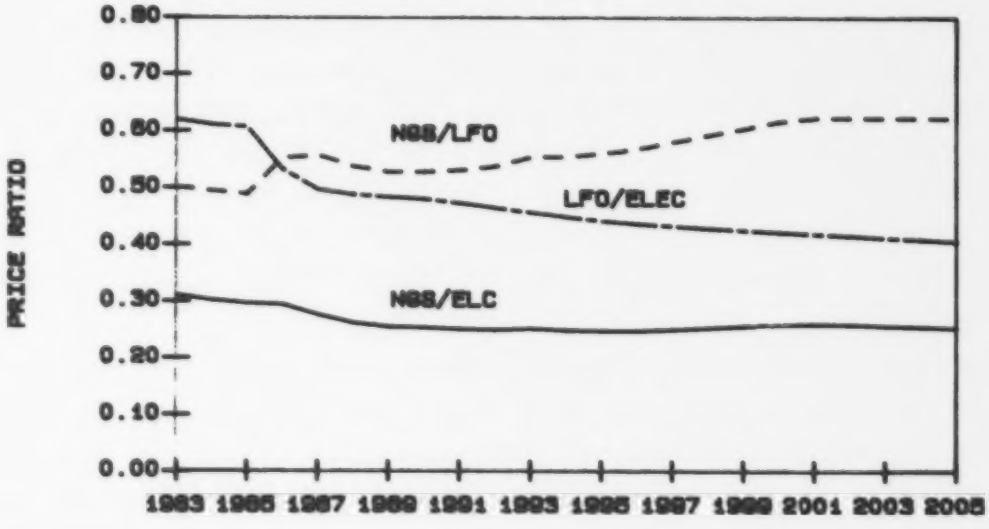
3.2.2 Energy Prices

Details underlying the refined petroleum product, natural gas and electricity price forecasts have already been provided in Chapter 2. The residential energy prices are summarized below.

Both light fuel oil and natural gas prices are forecast to decline in real terms. The real price of light fuel oil is expected to experience a significant decline over the short term from $7.46 per gigajoule in 1984 to $5.67 per gigajoule

by 1990 - a decline of about 24.0 percent. Beyond 1990, the real price of light fuel oil is expected to be flat and remain around the $5.50 per gigajoule level. Real natural gas prices are anticipated to experience a decline of about 19.0 percent by 1990. Over the remainder of the forecast period these prices are expected to gradually increase reaching a level of $3.47 per gigajoule, still well below the 1984 level. The real price of electricity, on the other hand, is forecast to increase at an annual average rate of 0.6 percent.

FIGURE 3.4
RELATIVE FUEL PRICES
RESIDENTIAL SECTOR



As shown in Figure 3.4, the 1984 natural gas price was about 30 percent of the price of electricity. This ratio is forecast to gradually decrease to 25.0 percent by 2005. The natural gas price was around 49 percent of the price of LFO in 1984, and is expected to increase to 56 percent by 1987 before experiencing a decline. By 2000 it is expected

to rise to 62 percent and stay at this level over the remainder of the forecast period. The price of light fuel oil relative to electricity is projected to decline significantly from 61 percent in 1984 to 40 percent by 2005.

3.2.3 Other Assumptions

Aside from economic, demographic and price considerations, energy demand in the residential sector is influenced by several other factors such as the operating efficiency of heating systems, the introduction of heat pumps and the application of solar technology.

Significant improvements in the efficiencies of conventional oil and gas furnaces are anticipated. In addition, high efficiency gas furnaces with a name plate efficiency of 90 to 95 percent are also expected to be in use over the forecast period. However, given the likely course of current natural gas prices, it appears that additional fuel savings resulting from use of high efficiency furnaces rather than conventional gas furnaces would not be sufficient to offset the additional capital investment. It has therefore been assumed that high efficiency furnaces will make only modest inroads into the stock of furnaces over time as the existing stock is turned over. The average fuel efficiency factors that underly this forecast are summarized in the following table.

Table 3.1

Heating Fuel Efficiency Factors

	Natural Gas		LFO	HFO	LPG
	Mainland	Vancouver Island			
1981-1985	0.65	--	0.65	0.80	0.65
1986-1990	0.66	0.67	0.65	0.80	0.65
1991-1995	0.68	0.70	0.65	0.80	0.65
1996-2000	0.70	0.72	0.65	0.80	0.65

Aside from improvements in oil and gas heating efficiencies, the overall average efficiency of electricity use is also expected to improve marginally due to the introduction of heat pumps. In addition, renewable energy applications such as solar and wood are forecast to contribute about 6.0 petajoules of energy on the Mainland and 2.0 petajoules on Vancouver Island by 2005.

3.3 Energy and Fuel Requirements Forecast

This section provides regional and provincial energy and fuel requirements forecasts. The provincial forecast is derived by aggregating the regional forecasts and by including the diesel fuel oil demand in the agriculture sector.

3.3.1 Mainland

Energy requirements for the Mainland (Table 3.2) are forecast to increase at an average rate of 2.0 percent per

TABLE 3.2

MAINLAND RESIDENTIAL SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	COAL AND COKE	HEAVY FUEL OIL	LIGHT FUEL OIL	L.P.G.	ELECT.	RENEWABLE ENERGY	TOTAL REQTS
1981	55.322	.781	.242	10.005	1.934	26.082	.000	94.366
1982	63.626	.012	.118	7.784	1.887	28.571	.000	101.998
1983	61.545	.005	.022	4.443	1.801	29.027	.000	96.843
1984	62.801	.007	.103	3.660	1.671	30.323	.000	98.565
1985	64.090	.007	.094	3.344	1.527	31.486	.000	100.548
1986	64.232	.006	.083	2.929	1.337	32.289	.188	101.064
1987	66.048	.007	.094	3.325	1.518	32.346	.384	103.722
1988	68.547	.008	.114	4.033	1.841	32.455	.595	107.593
1989	71.853	.009	.131	4.620	2.110	32.431	.821	111.975
1990	75.262	.009	.137	4.844	2.211	32.830	1.063	116.356
1991	75.774	.009	.137	4.834	2.207	33.725	1.318	118.004
1992	78.318	.009	.133	4.709	2.150	34.734	1.585	121.638
1993	80.148	.009	.132	4.664	2.130	35.835	1.859	124.777
1994	81.047	.009	.135	4.783	2.184	37.037	2.137	127.332
1995	81.531	.010	.141	4.990	2.278	38.273	2.422	129.645
1996	79.817	.010	.145	5.145	2.349	39.472	2.718	129.656
1997	80.649	.010	.149	5.265	2.404	40.798	3.029	132.304
1998	81.189	.011	.152	5.380	2.457	42.204	3.348	134.741
1999	80.985	.011	.157	5.543	2.531	43.862	3.669	136.758
2000	80.278	.011	.164	5.789	2.643	45.599	3.992	138.476
2001	79.243	.012	.171	6.044	2.760	47.268	4.334	139.812
2002	78.263	.012	.177	6.262	2.859	49.053	4.646	141.272
2003	77.872	.013	.181	6.398	2.921	50.730	4.996	143.111
2004	78.170	.013	.183	6.471	2.955	52.268	5.368	145.428
2005	78.722	.013	.183	6.489	2.963	53.678	5.750	147.798
				ANNUAL GROWTH RATES				
1984-1995	2.40	3.30	2.90	2.86	2.86	2.14	.00	2.52
1995-2005	-.35	2.66	2.64	2.66	2.66	3.44	9.83	1.32
1984-2005	1.08	2.99	2.77	2.76	2.77	2.76	.00	1.95

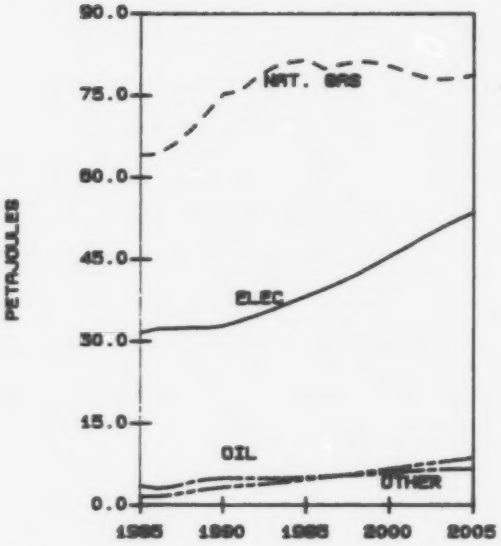
year: from 98.6 petajoules in 1984 to 147.8 petajoules by 2005. Over the first half of the forecast period (1984-1995), requirements are forecast to grow at an average rate of 2.5 percent per year dropping to 1.3 percent per year over the second half of the forecast period. This drop in energy demand in the second half of the forecast period is principally due to the increased use of electricity, a relatively more efficient fuel, and improvements in furnace efficiencies. Increased utilization of electricity in this period reflects the effect of stabilization in the price of electricity relative to the price of natural gas, as was shown in Figure 3.4.

The share of energy provided by natural gas on the Mainland is projected to decline from 63.7 percent in 1984 to 53.3 percent by 2005. The key factor contributing to this decline is a slow down in residential oil-to-gas conversions in response to a projected increase in the price of natural gas relative to light fuel oil. In addition, improvements in heating system designs and increased use of renewable energy are expected to contribute to further declines in natural gas' share. The demand for natural gas is forecast to increase at an annual average rate of 1.1 percent from 62.8 petajoules in 1984 to 78.7 petajoules by 2005.

In spite of the increase in electricity prices relative to LFO and the modest decline relative to natural gas, the electricity share on the Mainland is projected to increase from 30.8 percent in 1984 to 36.3 percent by 2005. This is because approximately 65 percent of the electricity in the residential sector is consumed for lighting and household appliances where other fuels cannot be substituted. Electricity demand, is expected to grow at an average rate

of 2.8 percent per year from 30.3 petajoules in 1984 to 53.7 petajoules in 2005. Most of this increase in electricity demand is expected to come about in the latter half of the forecast period during which increases in electricity prices moderate relative to natural gas.

FIGURE 3.5
MAINLAND ENERGY DEMAND
RESIDENTIAL SECTOR



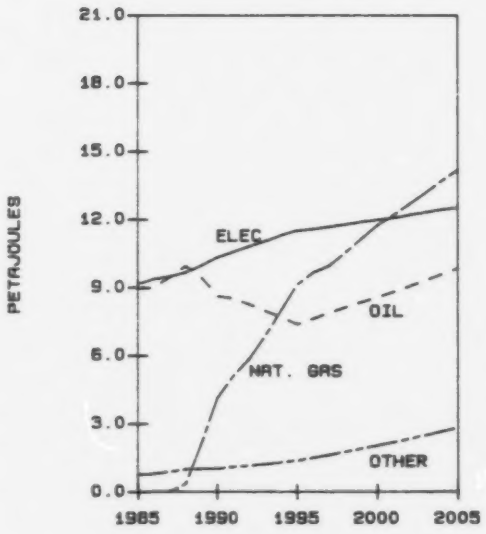
The consumption of refined petroleum products (excluding diesel fuel oil) is forecast to decline between 1984 and 1986 in response to the major oil price increases that occured during the early 1980's. Beyond 1986, however, the demand for these products is expected to grow at an average rate of 4.3 percent per year as oil price increases decline relative to the key competitor - natural gas. The RPP share is forecast to increase from 3.8 percent in 1984 to 4.5 percent in 2005.

The share of energy supplied by "other" fuels is expected to increase from 1.7 percent in 1984 to about 6.0 percent by 2005 (See Figure 3.5).

3.3.2 Vancouver Island

Energy requirements for Vancouver Island are summarized in Table 3.3. Total requirements on the Island are forecast to increase from 20.0 petajoules in 1984 to 37.5 petajoules in 2005 indicating an annual average growth rate of 3.0 percent (Figure 3.6).

FIGURE 3.6
VAN. ISLAND ENERGY DEMAND
RESIDENTIAL SECTOR



Over the forecast period, both electricity and oil are expected to experience declining market shares principally due to the extension of natural gas service to the Island in 1988.

The impact of the Vancouver Island pipeline and natural gas penetration on electricity and oil use was analysed separately. Oil and electricity shares were appropriately adjusted. These adjustments indicate that electricity and RPP shares will decrease from 47.4 and 48.5 percent in 1984 to 31.8 and 25.0 percent in 2005 respectively. The share of natural gas is forecast to increase from 9.4 percent in 1989 to 36.0 percent by 2005.

In absolute terms, the demand for refined petroleum products is forecast to decline from 9.7 petajoules in 1984 to a low of 7.0 petajoules by 1995. Over the second half of the forecast period, the demand for refined petroleum products

TABLE 3.3

VANCOUVER ISLAND RESIDENTIAL SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	COAL AND COKE	HEAVY FUEL OIL	LIGHT FUEL OIL	L,P,G,	ELECT,	RENEWABLE ENERGY	TOTAL REQTS
1981	.000	.170	.133	10.179	.996	7.704	.000	19.182
1982	.000	.003	.065	10.244	.975	8.124	.000	19.411
1983	.000	.001	.012	8.456	.928	7.001	.000	16.398
1984	.000	.002	.058	9.630	.804	9.469	.000	19.963
1985	.000	.001	.051	8.460	.707	8.700	.000	17.919
1986	.000	.001	.051	8.512	.711	8.940	.048	18.263
1987	.000	.001	.054	8.952	.748	9.041	.100	18.896
1988	.335	.002	.057	9.415	.786	9.207	.157	19.959
1989	2.031	.001	.054	8.932	.746	9.498	.224	21.486
1990	3.928	.001	.049	8.152	.681	9.838	.297	22.946
1991	4.846	.001	.048	8.037	.671	10.065	.373	24.041
1992	5.563	.001	.047	7.814	.653	10.309	.452	24.839
1993	6.530	.001	.045	7.535	.629	10.524	.536	25.800
1994	7.582	.001	.044	7.272	.607	10.764	.628	26.898
1995	8.683	.001	.042	6.973	.583	10.971	.724	27.977
1996	9.198	.001	.043	7.215	.603	11.028	.820	28.908
1997	9.480	.001	.045	7.464	.623	11.127	.923	29.663
1998	10.032	.001	.046	7.694	.643	11.226	1.030	30.672
1999	10.606	.001	.048	7.908	.661	11.336	1.143	31.703
2000	11.184	.001	.049	8.110	.678	11.423	1.260	32.705
2001	11.609	.001	.050	8.336	.696	11.507	1.376	33.575
2002	12.071	.001	.052	8.575	.716	11.628	1.501	34.544
2003	12.547	.001	.053	8.820	.737	11.745	1.631	35.534
2004	13.042	.002	.055	9.083	.759	11.859	1.767	36.567
2005	13.520	.002	.056	9.332	.780	11.940	1.904	37.534
				ANNUAL GROWTH RATES				
1984-1995	.00	-6.11	-2.89	-2.89	-2.88	1.35	.00	3.12
1995-2005	4.53	7.18	2.92	2.96	2.95	.85	10.15	2.98
1984-2005	.00	.00	-.17	-.15	-.14	1.11	.00	3.05

is expected to return to current levels by 2005. Requirements for electricity, however, are projected to increase from 9.5 petajoules in 1984 to 11.9 petajoules by 2005. Demand for natural gas is forecast to reach 13.5 petajoules by 2005.

3.3.3 The Province

The provincial energy requirements forecast shown in Figure 3.7 is derived by aggregating the Mainland and the Vancouver Island projections and by including the diesel fuel oil use in the agriculture sector.

Total residential energy demand in British Columbia is forecast to increase at a rate of 2.2 percent per year from a level of 121.8 petajoules in 1984 to 191.8 petajoules in 2005 (Table 3.4). Over 1984-1995, the first half of the forecast period, demand is expected to grow at a relatively higher rate of 2.7 percent per year. However, over the second half of the forecast period, 1995-2005, demand is projected to grow at a relatively slower average annual rate of 1.7 percent. This is caused by a moderation in electricity prices relative to natural gas prices, which generates a higher level of electricity use.

Downward pressure on energy demand during 1995-2005 is mitigated somewhat by higher demographic growth and the use of natural gas, a relatively less efficient fuel, on Vancouver Island.

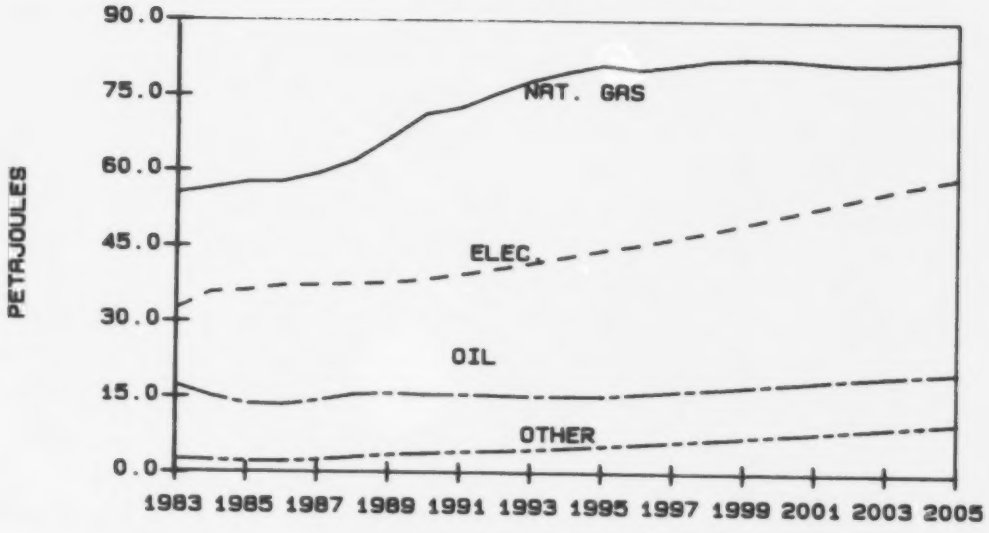
TABLE 3.4

PROVINCIAL RESIDENTIAL SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	COAL AND COKE	HEAVY FUEL OIL	LIGHT FUEL OIL	L.P.G.	ELECT.	DIESEL FUEL OIL	RENEWABLE ENERGY	TOTAL REQTS
1981	55.322	.951	.376	20.184	2.930	33.786	2.951	.000	116.500
1982	63.626	.015	.184	18.027	2.862	36.695	2.475	.000	123.884
1983	61.545	.006	.033	12.898	2.729	36.028	6.111	.000	119.350
1984	62.801	.009	.161	13.290	2.476	39.792	3.245	.000	121.774
1985	64.090	.008	.145	11.804	2.233	40.186	3.019	.000	121.485
1986	64.232	.007	.134	11.440	2.048	41.730	3.254	.236	122.581
1987	66.048	.008	.148	12.277	2.266	41.387	3.421	.484	126.039
1988	68.882	.009	.171	13.448	2.628	41.662	3.581	.752	131.133
1989	73.884	.011	.184	13.553	2.856	41.929	3.751	1.045	137.213
1990	79.190	.011	.186	12.996	2.892	42.668	3.921	1.360	143.224
1991	80.620	.011	.185	12.871	2.878	43.790	4.095	1.691	146.141
1992	83.881	.011	.180	12.523	2.803	45.043	4.279	2.037	150.757
1993	86.677	.010	.177	12.199	2.759	46.359	4.471	2.395	155.047
1994	88.629	.011	.179	12.055	2.791	47.801	4.671	2.765	158.902
1995	90.214	.011	.183	11.964	2.861	49.244	4.847	3.146	162.470
1996	89.015	.011	.189	12.360	2.952	50.500	5.017	3.538	163.582
1997	90.129	.012	.194	12.728	3.027	51.924	5.187	3.952	167.153
1998	91.222	.012	.198	13.074	3.099	53.430	5.361	4.378	170.774
1999	91.592	.012	.204	13.451	3.191	55.197	5.542	4.812	174.001
2000	91.462	.013	.212	13.900	3.321	57.021	5.690	5.252	176.871
2001	90.852	.013	.221	14.380	3.456	58.775	5.840	5.690	179.227
2002	90.334	.014	.229	14.837	3.575	60.681	5.996	6.147	181.813
2003	90.418	.014	.234	15.218	3.658	62.475	6.156	6.627	184.800
2004	91.212	.014	.238	15.554	3.713	64.127	6.319	7.135	188.312
2005	92.242	.014	.240	15.821	3.742	65.618	6.482	7.654	191.813
				ANNUAL GROWTH RATES					
1984-1995	3.35	1.84	1.17	-.95	1.32	1.96	3.72	.00	2.66
1995-2005	.22	2.44	2.75	2.83	2.72	2.91	2.95	9.30	1.67
1984-2005	1.85	2.13	1.92	.83	1.99	2.41	3.35	.00	2.19

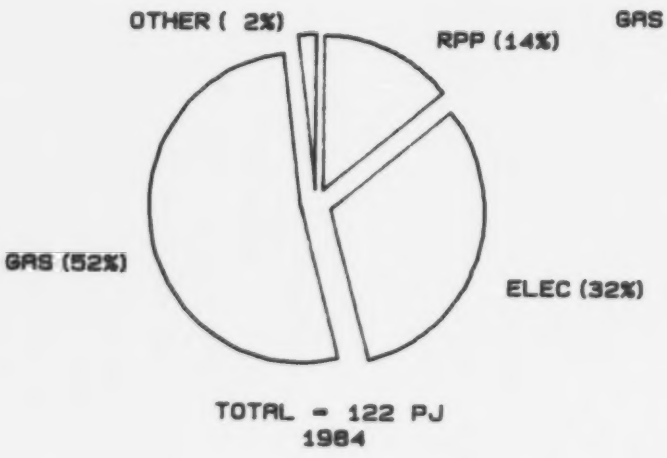
FIGURE 3.7
PROVINCIAL ENERGY DEMAND
RESIDENTIAL SECTOR

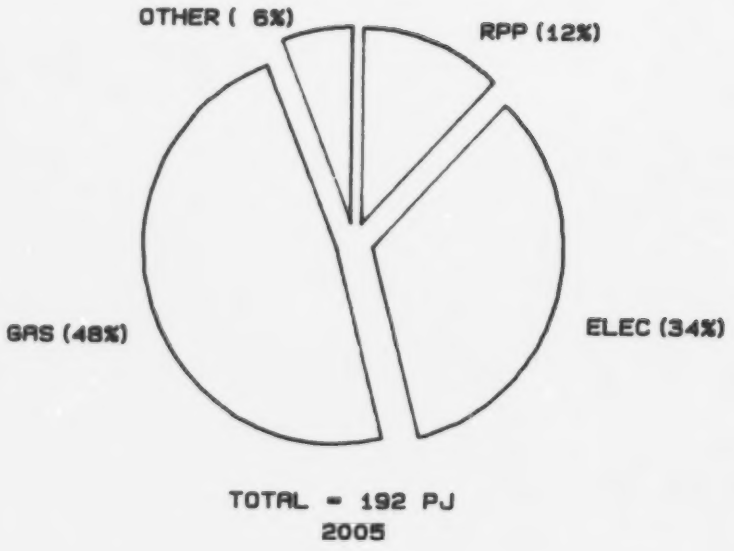


Provincial demand for electricity is expected to grow at an average rate of 2.4 percent per annum followed by natural gas at 1.8 percent per year. The demand for refined petroleum products, except diesel fuel oil is forecast to increase at an annual average rate of 0.8 percent. The consumption of diesel fuel oil, however, is anticipated to display significant growth, from 3.2 petajoules in 1984 to 6.5 petajoules in 2005 indicating an annual average growth rate of 3.3 percent.

The share of both natural gas and refined petroleum products are forecast to decline from 51.6 and 13.7 percent in 1984 to 48.1 and 12.4 percent respectively in 2005. Electricity is expected to maintain its current market share. "Other" fuels are expected to supply about 6.0 percent of the provincial energy requirements by 2005 (Figure 3.8).

FIGURE 3.8
RESIDENTIAL ENERGY REQUIREMENTS
(BRITISH COLUMBIA)





CHAPTER 4

COMMERCIAL SECTOR

4.0 Introduction

Commercial sector energy use refers to energy consumed in several service industries: finance, insurance and real estate; retail and wholesale trade; transportation and communication services; business services; personal services; and public administration. Energy in this sector is principally used in the form of natural gas and electricity. However, although substantial amounts of light fuel oil and diesel fuel are consumed in the public administration subsector.

The commercial energy requirements forecast have been determined separately for the Mainland and Vancouver Island. Energy requirements for both of these regions are estimated by relating energy demand to energy prices, degree days and commercial gross domestic product (GDP). Individual fuel demands are derived by applying market shares, which are dependent on relative fuel prices.

Within this chapter, Section 4.1 presents an historical overview of the composition and patterns of growth of the commercial sector, and a profile of historical fuel use. The underlying forecast of commercial sector economic activity and a summary of other exogenous assumptions is contained in Section 4.2. Finally, Section 4.3 presents the energy demand forecast. Total provincial commercial energy requirements are disaggregated to allow for an examination of individual fuel market shares as well as Mainland and Vancouver Island energy requirements.

4.1 Historical Profile

4.1.1 Economic Activity

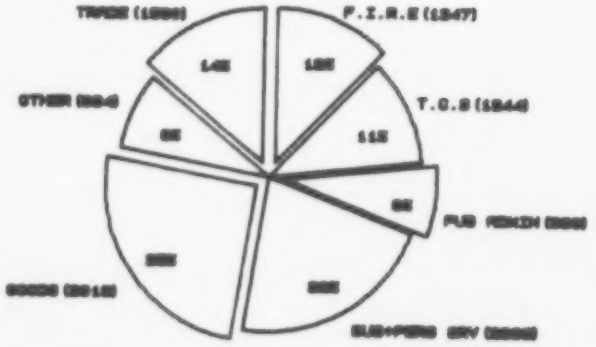
Through the 1970's and early 1980's economic growth in the commercial sector was stimulated by steadily increasing economic activity in goods producing sectors. The expansion of the economy resulted in a significant demand for commercial space to accomodate such activities as finance, insurance and real estate, education services, health services other personal and business services, and wholesale and retail trade. Further, B.C. continued as a popular tourist attraction, evidenced by substantial investment in the tourist accomodation and service industry.

Commercial sector GDP has grown more quickly than that of the provincial economy since 1970, increasing at average annual rates of 4.6 percent compared to 4.0 percent for total economic activity. Consequently, commercial sector activity as a proportion of total provincial economic activity increased from 63.8 percent in 1970 to 69.8 percent by 1984. The growth in commercial sector GDP was led by growth in finance, insurance and real estate (140.3 percent), and transportation, communications and storage (98.7 percent)(Figure 4.1).

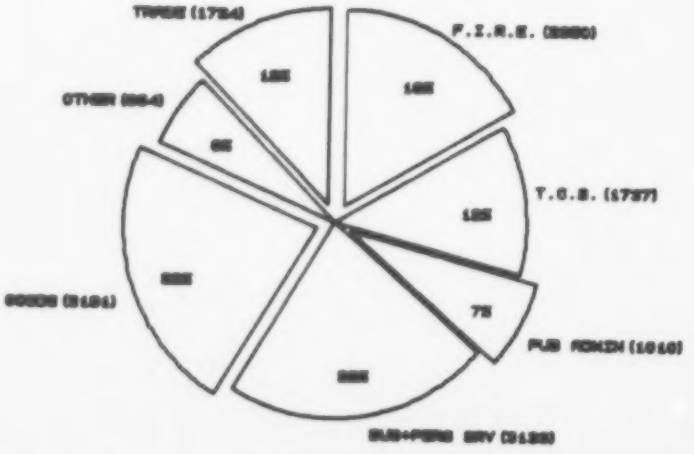
4.1.2 Energy Consumption

Currently the commercial sector accounts for approximately 11 percent of the total energy consumed in British Columbia compared to 9 percent in the early 1960's. The increase in its share is largely due to the larger role that the commercial sector plays in the British Columbia economy.

FIGURE 4.1
TOTAL PROVINCIAL G.D.P.
($1971, MILLIONS)



$11099
1974



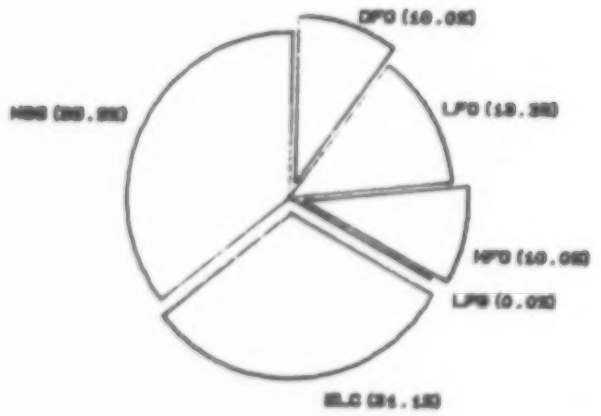
$14261
1984

During the 1960's and early 1970's, commercial sector energy requirements increased dramatically, at average annual rates of 9.8 percent. The high rate of growth reflected a rapidly expanding commercial sector (average annual growth rate of 5.7 percent), and an increasing energy intensity of commercial activity as fuel prices increased marginally (weighted average annual growth rate of 0.6 percent). Commercial sector energy requirements increased from 20.4 petajoules (PJ) in 1961 to 82.4 PJ by 1976.

Since the oil price shock in 1973, there has been a slowdown in commercial sector energy demand. Requirements have decreased from 69.1 PJ in 1974 to 79.4 PJ by 1984. High real energy prices have been a major constraint on commercial sector energy demand. The recent economic slowdown has also contributed to the drop in requirements. Real provincial GDP grew by only 2.7 percent annually from 1976 to 1984, and only 0.3 percent annually from 1980 to 1984. Likewise, commercial sector GDP increased by only 2.6 percent annually from 1980 to 1984.

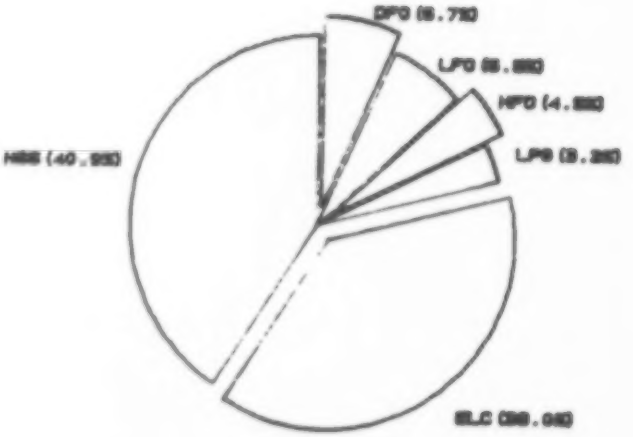
Consumption of all fuels demonstrated low rates of growth in the 1974-1984 period. However, both electricity and natural gas increased their share of total requirements at the expense of oil (Figure 4.2). For the most part, this reflected a change in relative prices which saw the real price of oil increase 9.0 percent annually over the 1976 to 1984 period while a composite price of natural gas and electricity increased only 2.1 percent per year.

FIGURE 4.2
COMMERCIAL ENERGY DEMAND



69.1 PETAJOULES

1974



79.4 PETAJOULES

1984

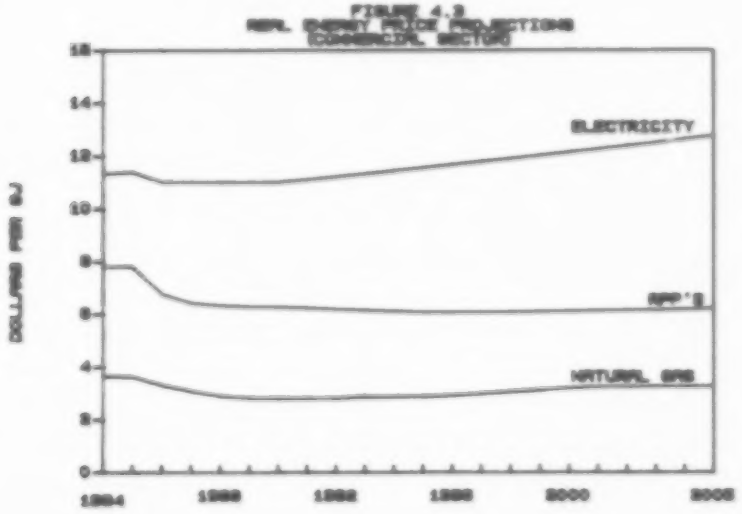
4.2 Forecast Period Assumptions

Based on expected world oil and domestic refinery gate crude prices as reported in Chapter 2 and the current structure of provincial taxes on fuel, commercial sector energy prices are expected to decline over the period 1986 to 1990, and then recover marginally at 0.7 percent per year to 2005 (Table 4.1, Figure 4.3).

Table 4.1
Real Energy Price Projections: Commercial Sector
($1981, Per GJ)

Year	RPP	Natural Gas	Electricity
1984	7.82	3.66	11.33
1990	6.26	2.79	10.99
1995	6.06	2.87	11.55
2000	6.11	3.19	12.14
2005	6.21	3.28	12.76

Prices of the four major refined petroleum products; light fuel oil, heavy fuel oil, diesel fuel, and liquid petroleum gases have been combined into a single, weighted, commercial sector oil price, referred to as RPP.



Light fuel oil, diesel fuel and natural gas prices are expected to decline in real terms over the near term. After 1997, diesel and light fuel oil prices are expected to increase marginally at an average annual rate of 0.1 percent per year. Natural gas prices are expected to increase at 1.0 percent per year starting in 1990. The real price of electricity, on the other hand, is forecast to increase throughout the forecast period, averaging 0.1 percent per year to 1990 and 1.0 percent per year thereafter.

Forecasts of demographic and economic activity are based on long-term projections outlined in Chapter 2 and indicate a gradual, steady growth for such variables as population, income and economic activity (Table 4.2).

Table 4.2
Demographic and Economic Projections
(Real Average Annual Growth Rate, Percent)

Year	Total Personal Disposable Income	Commercial G.D.P.	Population
1984-1990	3.1	3.0	1.2
1990-1995	3.4	3.5	1.4
1995-2000	3.2	3.5	1.5
2000-2005	3.0	3.2	1.6

On a sub-sectoral basis, the major deviations from the average annual commercial sector growth rates come in the short term. As a result of Expo 86, retail trade in British Columbia is forecast to increase 8.5 percent in 1986. Public administration is expected to continue to exhibit

slow growth rates in response to provincial and federal government policies of restraint (Table 4.2.1).

Table 4.2.1
Details of Commercial GDP Forecast
(Real, Average Annual Growth Rate, Percent)

Year	F.I.R.E.	Trade	T.C.S.	Public Admin.	Other Services
1984 - 1990	2.9	4.0	3.1	1.2	3.1
1990 - 1995	2.8	3.3	3.5	3.0	4.2
1995 - 2000	2.8	3.3	3.3	3.0	4.2
2000 - 2005	2.3	3.0	3.3	3.0	3.8

4.3 Requirements Forecast

Commercial sector energy requirements have been forecast separately for the mainland and Vancouver Island. Both forecasts draw on a top-down approach relating regional commercial energy requirements to projections of economic and demographic activity. Estimated fuel shares are used to calculate individual requirements for natural gas, electricity, light fuel oil, heavy fuel oil, diesel fuel and L.P.G.'s.

Commercial energy requirements are forecast to grow at an average annual rate of 2.8 percent through 2005: an increase of 79 percent from 79.4 PJ in 1984 to 142.3 PJ by 2005 (see Table 4.3).

TABLE 4.3

PROVINCIAL COMMERCIAL SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	HEAVY FUEL OIL	LIGHT FUEL OIL	DIESEL FUEL OIL	L,P,G,	ELECT,	TOTAL REQTS
1981	30.94	5.19	5.63	5.42	2.95	29.42	79.54
1982	34.11	3.41	6.49	4.42	3.12	30.31	81.86
1983	31.19	2.63	5.02	4.98	2.71	32.06	78.59
1984	32.53	3.60	5.21	5.34	2.56	30.16	79.40
1985	33.97	3.65	5.21	5.59	2.66	30.87	81.96
1986	35.99	3.90	5.56	6.07	2.89	32.41	86.81
1987	37.76	3.88	5.62	6.05	2.92	33.48	89.70
1988	40.87	3.52	4.88	5.80	2.74	34.44	92.25
1989	43.88	3.29	4.52	5.54	2.62	35.44	95.29
1990	45.83	3.16	4.18	5.56	2.59	36.33	97.66
1991	47.37	3.17	4.10	5.74	2.66	37.11	100.15
1992	48.72	3.26	4.10	6.05	2.80	37.90	102.82
1993	49.65	3.41	4.18	6.50	3.00	38.70	105.42
1994	50.98	3.51	4.20	6.85	3.16	39.44	108.14
1995	52.25	3.62	4.25	7.23	3.34	40.21	110.90
1996	54.37	3.83	4.41	7.80	3.61	41.85	115.86
1997	56.28	4.07	4.59	8.44	3.91	43.57	120.85
1998	58.12	4.32	4.79	9.13	4.24	45.37	125.95
1999	60.00	4.58	4.99	9.86	4.59	47.25	131.27
2000	61.81	4.84	5.18	10.60	4.95	49.10	136.47
2001	62.00	4.93	5.23	10.97	5.15	49.60	137.87
2002	62.57	4.97	5.23	11.21	5.29	50.04	139.32
2003	63.23	4.99	5.23	11.41	5.41	50.46	140.73
2004	63.89	4.99	5.22	11.59	5.52	50.83	142.04
2005	64.07	4.95	5.16	11.66	5.58	50.83	142.26
			ANNUAL GROWTH RATES				
1984-1995	4.40	.05	-1.84	2.81	2.46	2.65	3.08
1995-2005	2.06	3.18	1.98	4.89	5.28	2.37	2.52
1984-2005	3.28	1.53	-.04	3.79	3.79	2.52	2.82

Natural gas is expected to increase its share of total commercial sector energy requirements from 41 percent in 1984 to 45 percent in 2005 (Figure 4.4). The increase is due in part to the assumed commencement of natural gas service to Vancouver Island in 1988, and also to the relative price advantage natural gas is forecast to maintain over electricity, its principal competing fuel.

Real oil (RPP) and electricity prices are anticipated to remain above natural gas prices throughout the forecast period. Electricity and oil products are expected to be displaced by natural gas in the commercial sector. From 1984 to 2005, the RPP share decreases from 21 to 19 percent and the electricity share from 38 to 36 percent.

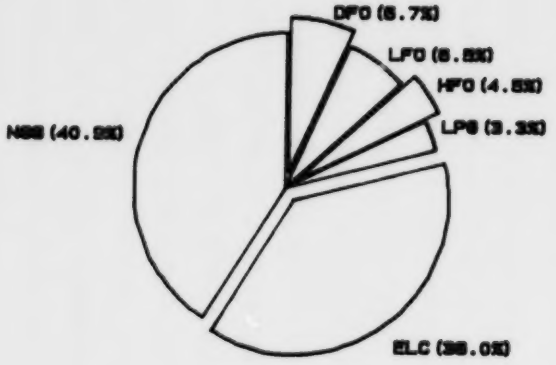
4.3.1 Mainland

Over the forecast period, it is anticipated that the share of RPPs will increase marginally from 18.9 percent of total commercial energy demand in 1984 to about 19.5 percent by the year 2005. Electricity share declines from its 1984 value of 35.5 percent to 34.4 percent in 2005. Natural gas' share remains relatively constant over the forecast period at about 46 percent.

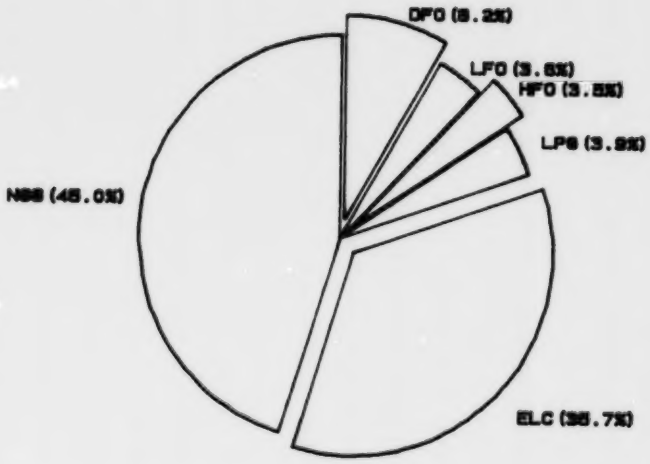
For the most part, changes in the fuel shares through the forecast period reflect the relative price disadvantage of electricity.

Within the RPP group, the share of diesel fuel was determined separately, because it is used in remoter areas of the province where fewer substitutes are available. Thus its use does not respond to changes in relative energy

FIGURE 4.4
COMMERCIAL ENERGY DEMAND



79.4 PETAJOULES
1984



142.3 PETAJOULES
2005

prices as does the use of other RPPs. Diesel fuel requirements are expected to increase on average, at 3.8 percent per year from 5.3 PJ in 1984 to 11.6 PJ in 2005.

Total RPP requirements are expected to grow robustly over the forecast period. In response to the previously noted economic growth forecast for the commercial sector, and the expected price advantage that these fuels will hold over electricity, their use is anticipated to grow by about 3.0 percent per year from 13.5 PJ in 1984 to 25.0 PJ in 2005.

Expansion of the natural gas distribution system and switching from oil to natural gas are expected to moderate over the forecast period. Extensions will be primarily into periphery areas where the volume of competing fuels displaced per kilometre of new pipe installed is much lower. Consequently, the impact of future expansions in the distribution system for natural gas demand is reduced.

Historically natural gas has accounted for approximately 50 percent of the total energy requirements of the trade, transportation and communications, and finance, insurance and real estate sub-sectors. For the period 1984 to 1990, declining real fuel prices and robust economic growth in these industries effect gas demand increases of about 4.8 percent per year. Increasing real fuel prices from 1990 to 2005, reduced impacts of expansions in the distribution network, and moderating economic growth after the year 2000, lead to a slowdown in natural gas sales growth to approximately 2.1 percent per year. Overall, natural gas requirements increase from 32.5 PJ in 1984 to 59 PJ by 2005.

Electricity requirements for the forecast period are expected to exhibit a slower growth rate than either natural gas or RPPs. Requirements are expected to increase only 2.7 percent per year from 25.3 PJ in 1984 to 44.0 PJ in 2005, largely due to a forecasted electric power price disadvantage.

Total Mainland commercial sector energy requirements will increase at an average annual growth rate of 2.8 percent, with requirements reaching 128.0 PJ by 2005, up from 71.4 PJ in 1984 (see Table 4.4).

4.3.2 Vancouver Island

The major issue with respect to Vancouver Island energy requirements is the introduction of natural gas, assumed to commence in 1988. Prior to the introduction of gas it is anticipated that the share of RPPs will increase at the expense of electricity as consumers adjust to the rapid decreases in real RPP prices of 1986. Electricity's share of Vancouver Island's commercial sector energy requirements had increased from 17 percent in the early 1960's to 60 percent by 1984 (see Table 4.5). By 1987 however, it is expected to decline to 58.4 percent.

Although some small amounts of electricity are used for heating purposes in the commercial sector (eg. tourist accommodation and small offices), it is expected that no electricity will be displaced by natural gas, once service commences to the Island, because of the relatively high capital costs of retrofitting. It has been assumed however, that all future heating requirements that would otherwise be met by RPPs for new commercial buildings will be provided by natural gas.

TABLE 4.4

MAINLAND COMMERCIAL SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	HEAVY FUEL OIL	LIGHT FUEL OIL	DIESEL FUEL OIL	L.P.G.	ELECT.	TOTAL RENTS
1981	30.94	4.45	3.47	5.37	2.31	25.14	71.67
1982	34.11	2.69	4.32	4.38	2.45	25.64	73.59
1983	31.19	1.70	3.23	4.93	2.10	27.52	70.66
1984	32.53	2.80	3.21	5.30	2.18	25.34	71.35
1985	33.97	2.90	3.25	5.55	2.30	25.77	73.74
1986	35.99	3.10	3.40	6.02	2.51	27.24	78.26
1987	37.76	3.05	3.27	5.99	2.51	28.36	80.94
1988	39.83	2.89	3.04	5.76	2.42	29.31	83.24
1989	41.65	2.72	2.80	5.50	2.33	30.32	85.32
1990	43.07	2.70	2.72	5.52	2.35	31.18	87.53
1991	44.35	2.75	2.71	5.70	2.44	31.92	89.87
1992	45.49	2.86	2.76	6.01	2.59	32.67	92.38
1993	46.24	3.04	2.87	6.46	2.80	33.44	94.84
1994	47.40	3.16	2.92	6.81	2.97	34.16	97.41
1995	48.50	3.29	2.98	7.19	3.16	34.90	100.02
1996	50.48	3.51	3.11	7.76	3.43	36.41	104.68
1997	52.24	3.74	3.25	8.39	3.73	38.00	109.34
1998	53.96	3.99	3.39	9.07	4.05	39.65	114.12
1999	55.72	4.26	3.54	9.80	4.40	41.38	119.09
2000	57.39	4.52	3.68	10.53	4.76	43.08	123.96
2001	57.47	4.61	3.67	10.90	4.96	43.43	125.04
2002	57.90	4.65	3.63	11.14	5.10	43.72	126.13
2003	58.42	4.67	3.57	11.33	5.22	43.97	127.17
2004	58.94	4.68	3.50	11.50	5.33	44.18	128.12
2005	59.01	4.64	3.40	11.56	5.38	44.04	128.03
			ANNUAL GROWTH RATES				
1984-1995	3.70	1.47	-.66	2.82	3.43	2.95	3.12
1995-2005	1.98	3.49	1.31	4.86	5.48	2.35	2.50
1984-2005	2.88	2.43	.27	3.79	4.40	2.67	2.82

TABLE 4.5

VANCOUVER ISLAND COMMERCIAL SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	HEAVY FUEL OIL	LIGHT FUEL OIL	DIESEL FUEL OIL	L.P.G.	ELECT.	TOTAL REQTS
1981	.00	.74	2.16	.05	.64	4.29	7.87
1982	.00	.72	2.17	.04	.67	4.67	8.27
1983	.00	.93	1.79	.05	.61	4.55	7.93
1984	.00	.80	2.00	.04	.38	4.83	8.04
1985	.00	.75	1.96	.04	.36	5.10	8.22
1986	.00	.80	2.15	.05	.39	5.17	8.55
1987	.00	.83	2.34	.05	.41	5.12	8.76
1988	1.04	.63	1.84	.04	.31	5.13	9.01
1989	2.23	.57	1.72	.04	.29	5.12	9.97
1990	2.76	.47	1.47	.04	.24	5.16	10.12
1991	3.02	.42	1.39	.04	.22	5.20	10.28
1992	3.23	.39	1.34	.04	.21	5.23	10.44
1993	3.41	.37	1.31	.04	.20	5.26	10.58
1994	3.59	.35	1.28	.04	.19	5.28	10.73
1995	3.75	.33	1.26	.04	.18	5.32	10.88
1996	3.89	.33	1.30	.05	.18	5.44	11.18
1997	4.03	.33	1.34	.05	.18	5.57	11.51
1998	4.16	.33	1.39	.05	.19	5.72	11.84
1999	4.29	.33	1.45	.06	.19	5.87	12.18
2000	4.42	.32	1.50	.06	.19	6.01	12.51
2001	4.54	.32	1.55	.07	.19	6.16	12.84
2002	4.68	.32	1.60	.08	.19	6.32	13.19
2003	4.81	.32	1.66	.08	.20	6.49	13.55
2004	4.94	.32	1.72	.09	.20	6.66	13.92
2005	5.06	.32	1.77	.10	.20	6.80	14.24
			ANNUAL GROWTH RATES				
1984-1995	.00	-7.70	-4.10	.44	-6.45	.88	2.79
1995-2005	3.04	-.46	3.42	8.62	.90	2.49	2.72
1984-2005	.00	-4.32	-.59	4.26	-3.02	1.65	2.76

In developing a forecast of natural gas capture rates, the Ministry has been guided by the forecast of requirements outlined in "Natural Gas Supply to Vancouver Island Technical Report" (VIGAS). Initial share values for natural gas correspond to those in the VIGAS study. However, the values in the final years reflect current forecasts of relative prices and economic growth. Most of the potential substitution is achieved by 1994 after which only modest increases are assumed in the natural gas share of total requirements. As on the mainland, the declining share for electricity in the 1995-2005 period reflects an increasing relative price disadvantage for electricity.

Total commercial energy requirements on Vancouver Island, are anticipated to increase at an average annual rate of 2.8 percent from 8.0 (PJ) to 14.2 (PJ) between 1984 and 2005. Electricity demand is forecast to grow at an average annual rate of only 1.6 percent as a result of the price disadvantage vis-a-vis RPPs. Requirements for refined petroleum products will decline at average annual rates of approximately 1.4 percent reflecting the displacement by natural gas. Natural gas requirements will increase from about 1.0 PJ in 1988 to 3.8 PJ by 1995, after which they are anticipated to increase at an average annual rate of 3.0 percent, reaching approximately 5.1 petajoules in 2005.

CHAPTER 5

INDUSTRIAL SECTOR

5.0 Industrial Sector Overview

5.0.1 Introduction

The industrial sector consists of 10 components: pulp and paper, wood, primary metals, chemicals, non-metallic minerals, petroleum and coal products, petrochemicals, other manufacturing, mining and other industrial. The other manufacturing category includes: food and beverages, metal fabrication, transportation equipment, printing and publication, machinery and other small industries. The other industrial category covers logging and construction.

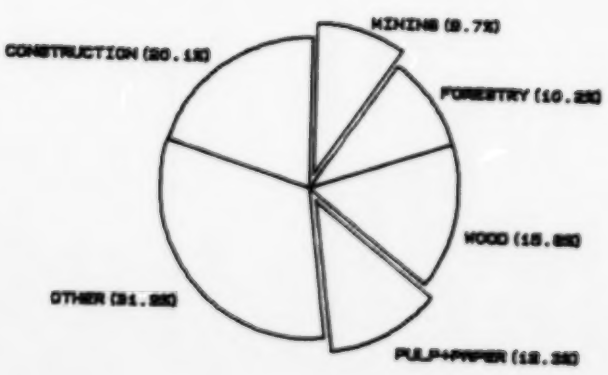
The forecast of end-use energy requirements is reported in this chapter. Consumption of feedstocks, such as natural gas for the production of petrochemicals, is reported in Chapter 7.

5.0.2 Historical Profile

The industrial sector in B.C. has been dominated by resource based activities (see Figure 5.0.1). For example, the primary forestry, mining, wood, and pulp and paper subsectors have accounted for 48 percent of total industrial real GDP since 1964.

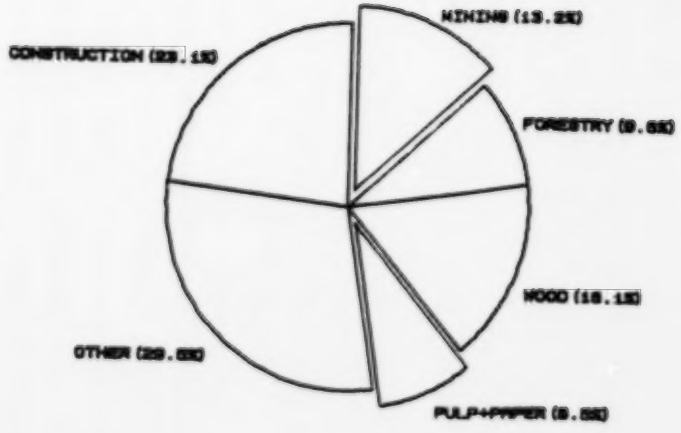
Between 1964 and 1984 total industrial GDP grew at an average annual rate of 3.4 percent, with the pulp and paper

FIGURE 5.0.1
COMPONENTS OF GDP
INDUSTRIAL SECTOR



1,917 MILLION 1971 DOLLARS

1964



3,832 MILLION 1971 DOLLARS

1984

and wood categories averaging 2.7 percent per year. Consequently, the share of pulp and paper and wood to total industrial GDP has fallen from about 28 percent in 1964 to about 25 percent in 1984.

The pulp and paper subsector accounts for over half the energy consumed in the industrial sector, (Figure 5.0.2) but only 9.5 percent of total industrial GDP. About 70 percent of pulp and paper fuel requirements are made up of energy produced within the sector, in the form of hog fuel and pulping liquors.

FIGURE 5.0.2
SECTORAL COMPOSITION OF
INDUSTRIAL TOTAL
ENERGY CONSUMPTION

379.2 PETAJOULES

1984

The wood sector accounts for about 13 percent of total industrial energy consumption. Most of these requirements are met by hog fuel.

Energy from own sources is also important in the primary metals sector. While primary metals accounts for only 9 percent of the total energy consumed in the industrial sector, almost 85 percent of this is supplied by self-generated hydroelectric power.

5.0.3 Forecast Period Assumptions

Economic activity as measured by industrial GDP is expected to increase at an average annual rate of almost 2.9 percent between 1984 and 2005 (see Table 5.0.1), down considerably from the 3.4 percent rate of the previous two decades.

The share of GDP attributable to the wood and pulp and paper subsectors is expected to fall from 25 percent in 1984 to 20 percent in 2005 as resource availability is constrained by the annual allowable cut. However, two new chemi-thermo-mechanical Pulp Mills (CTMP) to come on stream in the forecast period are assumed to utilize resources not included in the annual allowable cut.

The outlook for mining is less than that expected for the industrial sector as a whole. Among the major factors underlying the low growth rate of 2.6 percent per year are high real interest rates and competitive pressures from new mines in developing countries.

Apart from the dramatic growth in metallurigical coal output over the 1984 and 1985 period, with the commencement of coal production from the northeast, the outlook for coal is for moderate growth in the longer term as increased competition is experienced from overseas suppliers. Moderating oil prices will also reduce the attractiveness of thermal coal.

TABLE 5.0.1

DETAILS OF INDUSTRIAL GDP FORECAST

(MILLIONS OF 1971 DOLLARS)

	PRIMARY	MINING			MANUFACTURING					CONSTRUCTION	TOTAL
YEAR	FORESTRY	METALLIC	COAL	OTHER	WOOD	PAPER	PRI, MTL,	FOOD, BEV,	OTHER		INDUSTRIAL
1981	358	278	97	97	599	356	144	277	959	1163	4328
1982	299	207	101	86	514	317	106	270	749	1009	3678
1983	362	206	104	111	627	334	119	273	717	976	3829
1984	362	222	141	113	604	321	127	272	705	869	3755
1985	371	218	181	112	647	363	119	281	774	885	3900
1986	373	219	186	110	660	376	128	294	758	921	4025
1987	378	224	190	112	682	391	132	295	790	980	4173
1988	387	231	193	114	696	406	135	300	824	1022	4300
1989	401	229	194	116	722	417	138	306	859	1068	4450
1990	407	234	202	118	736	427	141	314	899	1116	4594
1991	411	239	210	120	743	440	144	323	941	1160	4733
1992	415	246	219	123	751	453	148	333	985	1207	4879
1993	420	253	228	125	758	467	152	343	1030	1255	5030
1994	424	261	237	127	766	481	156	353	1079	1305	5188
1995	428	269	246	130	774	495	159	364	1124	1357	5346
1996	430	277	256	131	777	505	163	373	1171	1405	5488
1997	432	285	266	133	781	515	166	382	1220	1454	5635
1998	434	293	277	135	785	526	169	392	1265	1498	5774
1999	437	302	288	137	789	536	173	400	1312	1543	5916
2000	439	311	299	139	793	547	175	408	1361	1589	6060
2001	439	321	311	140	797	552	178	416	1411	1636	6201
2002	439	330	321	142	801	558	180	424	1464	1686	6343
2003	439	340	330	143	805	564	181	433	1518	1736	6489
2004	439	350	340	145	809	569	183	441	1575	1788	6640
2005	439	361	350	146	813	575	185	450	1634	1842	6795
					ANNUAL GROWTH RATES						
1984-1995	1.53	1.75	3.92	1.27	2.27	4.04	2.09	2.69	4.34	4.14	3.26
1995-2005	.25	3.00	3.60	1.21	.50	1.50	1.50	2.15	3.81	3.10	2.43
1984-2005	.92	2.34	3.77	1.24	1.42	2.82	1.81	2.43	4.09	3.64	2.86

Economic diversification and high-tech industrial activity, such as electronics, will stimulate "other manufacturing" GDP to grow at an average annual rate of almost 4.1 percent between 1984 and 2005.

Construction, a small energy user relative to other industries is expected to grow at an average annual rate of 3.6 percent between 1984 and 2005 (1984 represents a bottoming out year and consequently inflates the long run growth rate). Housing starts are expected to increase from the current level of 18 thousand units per year to 30 thousand units in 1990 and 35 thousand in 2005. Non-residential construction will pick up in the late eighties in response to lower real interest rates, depletion of the current surplus of office space and proposed major capital projects such as the Vancouver Island Natural Gas pipeline and various hydroelectric investments.

5.0.4 Total Energy and Fuel Requirements

Total industrial energy requirements are forecast to increase from approximately 379 PJ in 1984 to 520 PJ in 2005, an average annual rate of 1.5 percent (see Table 5.0.2). Total energy use grows more rapidly in the 1984 - 1995 period than in the 1995 - 2005 period. This reflects higher economic growth and lower real energy prices in the earlier period. Moreover, total energy requirements in the most energy intensive component of the industrial sector - pulp and paper - are forecast to increase at only 0.4 percent in the latter period, reflecting a binding resource constraint.

TABLE 5.0.2

INDUSTRIAL SECTOR ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	HEAVY FUEL OIL	COAL AND COKE	LIGHT FUEL OIL	L,P,G,	DIESEL FUEL OIL	HOG FUEL	PULPING LIQUORS	OTHER	ELECT,	SELF-GEN ELECTRICITY	TOTAL REQTS
1981	70.926	28.945	.003	1.277	1.389	29.398	62.523	101.333	.000	43.573	31.107	370.474
1982	66.792	27.010	.003	1.008	1.010	26.508	63.490	100.445	.000	43.728	28.575	358.569
1983	74.048	25.464	.010	1.401	1.060	21.825	71.902	108.087	.000	44.452	27.368	375.617
1984	71.321	25.852	2.681	1.452	1.339	25.710	71.503	106.114	.000	47.367	25.988	379.347
1985	73.050	30.057	3.999	1.629	1.693	29.815	79.491	120.523	.000	54.177	28.951	423.385
1986	64.162	27.995	9.977	1.493	1.769	30.710	84.975	119.975	.332	56.740	28.667	426.995
1987	64.161	27.670	11.455	1.760	1.780	31.582	89.636	120.742	.332	55.712	29.582	434.432
1988	71.822	22.528	13.041	1.494	1.025	31.807	87.844	122.637	1.242	55.601	29.708	438.749
1989	73.503	22.990	14.227	1.527	1.001	32.093	87.896	123.906	1.269	55.617	29.834	443.863
1990	73.893	23.495	16.375	1.549	.971	32.250	87.737	123.251	1.282	57.567	29.897	448.267
1991	77.574	24.079	16.849	1.582	.954	32.652	89.013	126.699	1.290	57.169	29.897	457.758
1992	78.393	24.069	17.077	1.616	.930	33.008	88.859	124.593	1.299	59.420	29.897	459.161
1993	79.367	24.325	17.383	1.668	.956	33.993	89.844	126.374	1.300	60.135	29.897	465.242
1994	79.117	24.522	17.754	1.720	.977	34.986	90.190	127.095	1.300	60.651	29.897	468.209
1995	75.992	24.988	19.621	1.755	.977	37.964	90.330	127.817	1.301	59.533	29.897	470.175
1996	76.412	25.362	20.342	1.799	.990	40.320	93.668	128.245	1.300	59.625	29.897	477.960
1997	76.339	26.477	21.789	1.862	1.015	42.494	91.459	128.675	1.326	60.219	31.222	482.877
1998	76.505	26.609	21.936	1.923	1.029	43.255	91.481	129.106	1.325	61.197	31.222	485.588
1999	76.590	26.737	22.074	1.987	1.041	44.035	91.474	129.538	1.324	61.806	41.626	498.232
2000	76.629	26.859	22.203	2.051	1.054	44.833	91.439	129.972	1.322	62.414	41.626	500.402
2001	74.504	27.723	22.252	2.108	1.064	45.918	93.447	130.408	1.320	61.268	45.389	505.401
2002	74.165	28.286	22.196	2.153	1.076	47.316	93.426	130.845	1.318	60.982	46.195	508.158
2003	74.065	28.705	22.130	2.202	1.094	50.688	93.450	131.284	1.316	61.055	46.195	512.184
2004	74.395	28.845	22.406	2.253	1.113	51.632	93.466	131.725	1.315	61.516	46.195	514.861
2005	75.386	29.002	22.719	2.304	1.131	52.585	93.707	133.629	1.315	62.338	46.195	520.306
						ANNUAL GROWTH RATES						
1984-1995	.58	-.31	19.84	1.74	-2.96	3.61	2.15	1.71	.00	2.10	1.28	1.97
1995-2005	-.08	1.50	1.48	2.76	1.47	3.31	.37	.45	.11	.46	4.45	1.02
1984-2005	.26	.55	10.71	2.22	-.87	3.47	1.30	1.10	.00	1.32	2.78	1.52

A number of significant trends in individual fuel requirements can be noted. Some of the pulp and paper mills on Vancouver Island have planned or are planning to install equipment which uses coal and/or petroleum coke instead of heavy fuel oil. Cement plants in the lower mainland are in the process of displacing natural gas with coal. Consequently, the Ministry anticipates that the requirements for coal and coke could grow from 2.7 PJ in 1984 to 23 PJ by 2005.

Major industrial customers are assumed to make direct purchases of natural gas as natural gas prices are deregulated. However, this is anticipated to be insufficient to prevent a reduction in natural gas use by the cement, and pulp and paper industries. Commencement of natural gas service to Vancouver Island will prevent the share of natural gas from falling more dramatically.

Between 1985 and 1989, purchased electricity reflects the impact of electricity rate discounts and incentive pricing. These discounts originate from the Turbine Turn Down and Block Recovery Pricing programs offered by B.C. Hydro and from the B.C. Government Industrial Electricity Rate Discount Act (Bill 28) and Critical Industries Act (Bill 31). Self-generated electricity requirements will also increase when a new aluminum smelter is brought onstream in the 1990's.

The trend toward increasing use of forest waste will continue in the forest product sectors, with the installation of turbogeneration facilities, upgrades of power boilers and conversions of lumber drying kilns to burn hog fuel.

Hog fuel requirements are projected to grow at an average annual rate of 2.1 percent between 1984 and 1995, and to drop to 0.4 percent per year between 1995 and 2005, as the forest sector is constrained by the available resource.

Pulping liquors which accounted for about 28 percent of total industrial energy requirements in 1984, are forecast to grow in line with kraft pulp production at a rate of 1.7 percent per year between 1984 and 1995, falling to 0.4 percent per year thereafter.

5.1 Forestry

Introduction

The forestry subsector consists of pulp and paper, and wood products industries. Energy requirements for the logging industry have been included within the "other industrial" category. The pulp and paper industry presently encompasses 4 integrated newsprint mills, 15 kraft pulp mills, 4 paper mills and 1 mechanical mill. These 24 mills consumed 219 petajoules of energy in 1984 or 57 percent of total industrial energy requirements. The wood products industry consists of a large number of operations which vary significantly in size and type. In 1984, these operations consumed 48 petajoules of energy, amounting to 13 percent of total industrial energy requirements.

In total, the forestry subsector accounted for nearly 70 percent of total industrial energy requirements and about 34 percent of total provincial energy requirements, making it the largest single energy consumer in the province.

The production and energy requirements of the pulp and paper and wood products industries are examined together, reflecting the dependence which the pulp and paper industry has upon the wood products industry and the dependence which both have upon a common forestry resource. The wood products industry converts a large volume of timber into chips which are used by the pulp and paper industry in the production of pulp. Waste materials from the wood products industry are consumed by both the wood products and pulp and paper industries for energy in the form of hog fuel. A change in production levels or technologies of either industry may affect the production of the other.

5.1.1 Pulp and Paper

5.1.1.1 Historical Profile

Of the 24 pulp and paper mills currently operating in British Columbia, four large integrated mills on the Coast produce kraft and mechanical pulps and transform this into finished newsprint and market kraft products. Additionally, four sulfate kraft mills are located on the South Coast, with another mill producing sulfite kraft. On the Lower Mainland, there are four paper product mills producing a wide range of products. Eight sulfate kraft mills are located in the Interior with two additional mills on the north coast. One refiner of mechanical pulp and one chemi-thermo-mechanical pulp producer are operating in the Interior. A small newsprint mill at Ocean Falls was closed in 1979.

For the purpose of econometric modelling and forecasting purposes, the mills have been aggregated into five broad categories where processes are similar.

Energy consumption varies significantly between mills according to the product manufactured and technology employed. A profile of energy requirements in 1984 (the last actual figures available) for the 5 broad categories is reported in Figure 5.1.1. Of major significance, apart from the difference in total energy requirements among the groups, is that the south coastal kraft and integrated newsprint mills do not have access to natural gas and consequently must rely on heavy fuel oil.

Kraft pulp mills require large volumes of steam to meet the heat requirements of the pulping process. However, these mills produce and consume significant volumes of energy in the form of pulping liquors and hog fuel. There are three major areas of energy consumption: recovery boilers, lime kilns and power boilers.

The kraft pulping process produces pulping liquor which contains residual chemicals and dissolved wood fibre (lignin). Pulping liquor is burned in a recovery boiler to retreive the chemicals from the liquor and the resulting heat is employed to generate steam for the mill operation. A small amount of fossil fuel is consumed in the recovery boiler. The lime kiln transforms some of the chemicals recovered from the pulping liquors into a form reuseable in the process, and is fired principally by natural gas or heavy fuel oil. The power boilers provide additional steam for mill operation and are fired principally by hog fuel, natural gas and heavy fuel oil.

Kraft mills consume considerable volumes of hog fuel in generating steam as it is generally the least cost fuel. Hog fuel is a waste product produced on site through

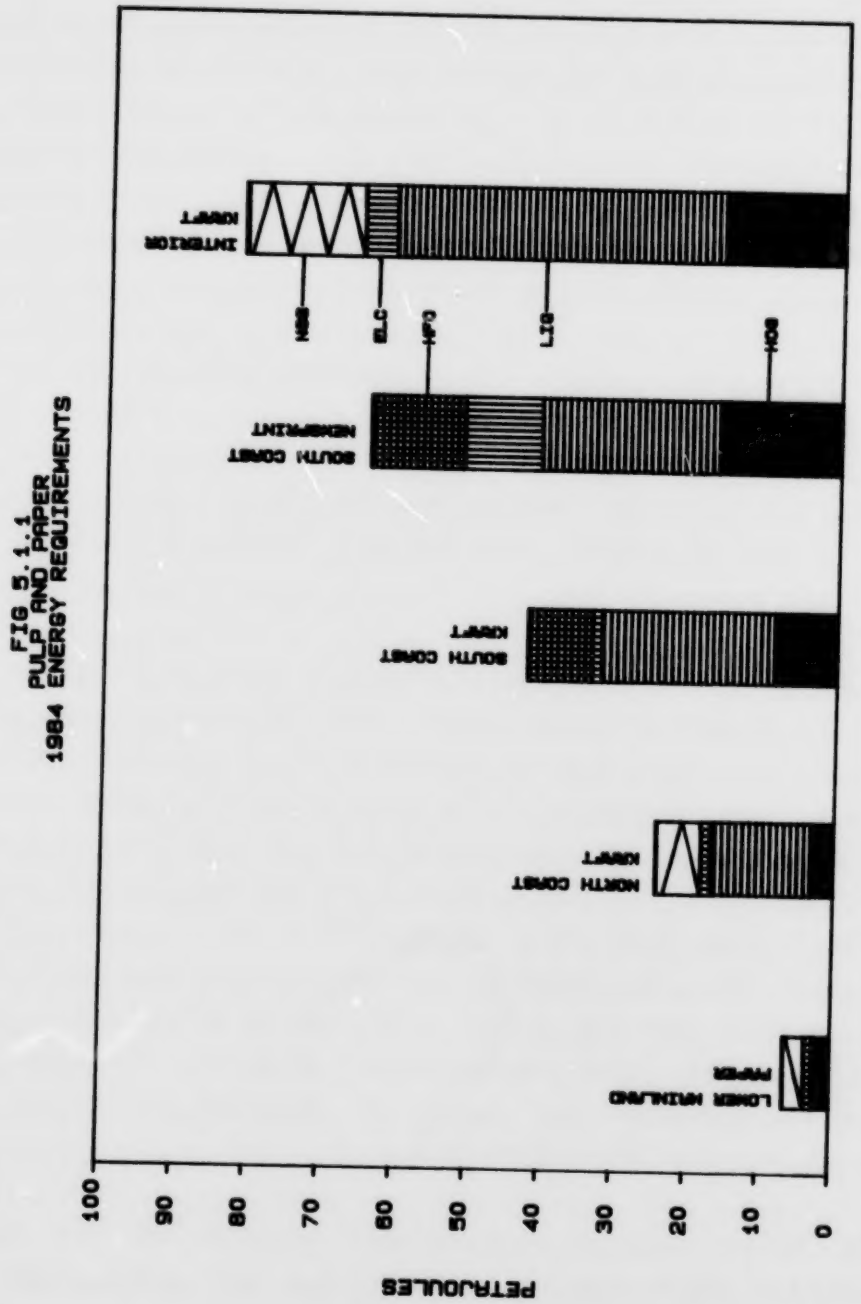


FIG 5.1.1
PULP AND PAPER
1984 ENERGY REQUIREMENTS
PETAJOULES
100
90
80
70
60
50
40
30
20
10
0
LOWER MAINLAND
PAPER
NORTH COAST
KRAFT
SOUTH COAST
KRAFT
SOUTH COAST
NEWSPRINT
INTERIOR
KRAFT
BRK
BLC
HFO
LIQ
NGS

chipping or associated wood product activities. Hog fuel must be burnt to generate heat or disposed of in land fills or bee-hive burners. Consequently the cost of hog fuel to a pulp mill is often only the cost of transport.

The production of high pressure steam in kraft pulp mills allows the possibility of installing turbogenerators for the generation of electricity. Electricity is produced by reducing the pressure of steam by passing it through a turbogenerator.

Newsprint operations are highly electricity intensive, requiring electricity in the production of stoneground and thermo-mechanical pulps as well as in the operation of the newsprint machines.

The production of newsprint requires the processing of a mixture of kraft pulp with stoneground or mechanical pulp. The introduction of thermo-mechanical pulp (TMP) in displacing stoneground pulp has allowed producers to reduce the share of fibre in kraft pulp. This phenomenon allows producers to employ existing fibre sources more efficiently but has also led to an increase in electricity requirements as TMP requires more electricity than does stoneground pulp.

5.1.1.2 Forecast Period Assumptions

As noted above, the forecast of energy requirements and output in the pulp and paper sector is integrated with the outlook for the wood sector through the availability of wood chips, sawdust and hog fuel. The forecast has accounted for

improvements in recovery rates experienced over the past five years in the production of lumber in the Interior. This has led to a reduction in the availability of both sawdust and wood chips. An increase in the consumption of sawdust as furnish in the production of kraft pulp, however, has been incorporated into the forecast. Furnish is the raw material for the production of pulp.

The use of the TMP process has become more widespread in the coastal mills over the past decade. Further, the proportion of pulp furnish in the production of newsprint represented by TMP is expected to increase assuming that the Port Alberni newsprint operation will be converted to use TMP.

Presently, there is only one mill in the province which produces market chemi-thermo-mechanical pulp (CTMP) - the West Fraser Mill located at Quesnel. Recently, there have been proposals to build two additional market CTMP mills in the province. Plans by Makin Pulp and Paper Ltd. call for a 180,000 tonne per year coated paper mill to be located at Britannia Beach and to be in operation by the late 1980's. It is intended that this mill would use aspen from the Interior and would purchase softwood chips. Fibreco Export Incorporated, a consortium of 35 B.C. Interior sawmills, has also recently announced plans for a 170,000 tonne per year bleached CTMP mill to be in operation by the late 1980's. The chips for this mill will be supplied from those already produced by the consortium and that currently are exported.

The CTMP process is a high yield pulping technology which converts about 90 percent of the input fibre into finished pulp compared to the kraft pulping process which converts

only about 50 percent. Capital requirements for CTMP technology are significantly lower than those of the greenfield bleached kraft technology. It is also possible to use some hardwoods and softwoods that would otherwise not be used.

Despite the advantages of the CTMP process jurisdictions other than British Columbia offer better fibre potential, notably Alberta, and may be closer to the final consumer. Consequently, the Ministry has assumed that only two CTMP mills will be built and in operation by the early 1990's.

Pulp and paper products production is assumed to increase at the rate of growth of real GDP in the pulp and paper sector (see Table 5.1.1). Accordingly, total market kraft pulp has been forecast to increase from 3.4 million tonnes in 1984 to 4.6 million tonnes in 2005, an average annual rate of almost 1.2 percent. Newsprint production is forecast to increase from 1.2 million tonnes in 1984 to 1.9 million tonnes by 2005. The other products category includes production from the four lower mainland paper mills, the Finlay Forest Mill, the West Fraser CTMP mill and the two additional CTMP mills assumed in this forecast. By the year 2005, CTMP production amounts to about 0.36 million tonnes or 4.8 percent of the total output.

In developing the output forecast, the maximum allowable cut has been held constant throughout the forecast period. With this constraint, the provincial supply of wood chips is fully used. Further, it is assumed that lumber production will be reduced.

TABLE 5.1.1

FORECAST OF PULP AND PAPER PRODUCTION

(MILLION OF TONNES)

YEAR	KRAFT PULP			NEWSPRINT	OTHER PRODUCTS	TOTAL
	COAST	INTERIOR	TOTAL			
1978	2.347	1.709	4.056	1.326	.357	5.740
1979	2.192	1.695	3.887	1.282	.369	5.539
1980	2.305	1.820	4.125	1.358	.367	5.850
1981	1.961	1.467	3.427	1.216	.355	4.998
1982	1.774	1.604	3.378	1.252	.430	5.060
1983	1.911	1.907	3.819	1.461	.514	5.793
1984	1.854	1.702	3.556	1.415	.565	5.536
1985	2.099	1.942	4.041	1.602	.625	6.268
1986	2.176	1.820	3.997	1.661	.638	6.296
1987	2.263	1.738	4.001	1.727	.650	6.378
1988	2.315	1.737	4.052	1.790	.650	6.492
1989	2.344	1.741	4.085	1.840	.650	6.575
1990	2.370	1.679	4.049	1.870	.820	6.739
1991	2.403	1.776	4.178	1.870	.820	6.868
1992	2.436	1.768	4.204	1.870	1.000	7.074
1993	2.405	1.872	4.277	1.870	1.000	7.147
1994	2.405	1.900	4.305	1.870	1.000	7.175
1995	2.405	1.928	4.333	1.870	1.000	7.203
1996	2.405	1.944	4.349	1.870	1.000	7.219
1997	2.405	1.961	4.366	1.870	1.000	7.236
1998	2.405	1.977	4.382	1.870	1.000	7.252
1999	2.405	1.994	4.399	1.870	1.000	7.269
2000	2.405	2.011	4.416	1.870	1.000	7.286
2001	2.405	2.028	4.433	1.870	1.000	7.303
2002	2.405	2.045	4.450	1.870	1.000	7.320
2003	2.405	2.062	4.467	1.870	1.000	7.337
2004	2.405	2.079	4.484	1.870	1.000	7.354
2005	2.405	2.152	4.557	1.870	1.000	7.427
			ANNUAL GROWTH RATES			
1984-1995	2.40	1.14	1.81	2.57	5.33	2.42
1995-2005	.00	1.11	.51	.00	.00	.31
1984-2005	1.25	1.12	1.19	1.34	2.76	1.41

5.1.1.3 Total Energy and Fuel Requirements Forecast

This forecast covers both purchased and non-purchased fuels. Consumption of the non-purchased fuels, pulping liquor and hog fuel, is based on production levels, historical patterns, availability and expected investments in facilities using non-purchased fuels. Electricity use from own-hydro and cogeneration is included in total electricity requirements, and is based on pulp and paper production levels, the mix of pulp furnish in the newsprint process and real electricity prices.

Purchased fuel requirements are primarily met by natural gas or heavy fuel oil which are burned in the lime kilns and power boilers. Liquified petroleum gases and diesel fuel oil are used to meet ancillary requirements.

Except for some anticipated improvement in the utilization efficiency of pulping liquors at the Harmac mill, pulping liquor requirements will vary directly with output. Hog fuel requirements depend on availability and the ability of each mill to use it. In this regard, several mills plan to undertake investments to increase the consumption of hog fuel. The current forecast reflects the Ministry's estimates of increased requirements for Crofton as well as those of other mills on the mainland. Consequently, total provincial hog fuel requirements are anticipated to increase from 47 PJ in 1984 to 61 PJ in 2005 (see Table 5.1.2).

Electricity requirements, including purchased and self-generated electricity, are anticipated to increase from 19.0 PJ in 1984 to 27 PJ in 2005. This forecast assumes that two Interior mills and one north coast mill will install turbo-

TABLE 5.1.2

FORECAST OF PULP AND PAPER ENERGY REQUIREMENTS; PROVINCE

(PETAJOULES)

YEAR	NATURAL GAS	COAL AND COKE	HEAVY FUEL OIL	L,P,G,	DIESEL FUEL OIL	HOG FUEL	PULPING LIQUORS	OTHER	ELECT,	SELF-GEN ELECTRICITY	TOTAL REQTS
1981	26.84	.00	25.81	.18	.75	38.71	101.33	.00	15.21	1.89	210.72
1982	27.01	.00	24.49	.19	.50	41.37	100.45	.00	16.72	1.74	212.47
1983	25.80	.00	22.37	.14	.48	50.55	108.09	.00	17.97	1.93	227.34
1984	24.79	.00	21.96	.17	.40	46.85	104.11	.00	17.83	1.18	219.29
1985	25.49	.00	24.99	.19	.44	53.10	120.52	.00	21.83	1.87	248.45
1986	23.62	1.56	22.63	.18	.39	53.07	119.98	.33	23.10	1.87	246.72
1987	23.28	2.35	22.06	.16	.34	56.29	120.74	.33	20.95	1.87	248.37
1988	28.90	3.10	17.51	.15	.31	53.93	122.64	1.24	20.97	1.87	250.63
1989	30.74	3.2b	18.00	.15	.32	53.42	123.91	1.27	21.04	1.87	253.96
1990	31.48	3.34	18.3[illegible]	.15	.31	53.12	123.25	1.28	22.34	1.87	255.69
1991	34.46	3.36	19.00	.16	.34	54.40	126.70	1.29	21.46	1.87	263.04
1992	34.73	3.20	18.85	.16	.34	54.31	124.59	1.30	23.71	1.87	263.06
1993	35.15	3.14	18.94	.16	.35	55.13	126.37	1.30	23.93	1.87	266.35
1994	35.03	3.14	18.96	.16	.35	55.42	127.10	1.30	24.08	1.87	267.42
1995	34.92	3.16	19.04	.16	.35	55.57	127.82	1.30	24.23	1.87	268.42
1996	34.70	3.16	19.06	.16	.35	59.00	128.25	1.30	24.36	1.87	272.21
1997	34.91	3.33	19.85	.17	.36	56.90	128.68	1.33	24.49	1.87	271.88
1998	34.46	3.33	19.86	.17	.36	57.07	129.11	1.33	24.61	1.87	272.36
1999	34.38	3.33	19.85	.17	.36	57.25	129.54	1.32	24.74	1.87	272.79
2000	34.07	3.32	19.83	.17	.35	57.42	129.97	1.32	24.86	1.87	273.19
2001	32.32	3.32	19.81	.17	.35	59.63	130.41	1.32	24.98	1.87	274.18
2002	32.05	3.32	19.80	.17	.35	59.79	130.85	1.32	25.09	1.87	274.60
2003	31.82	3.32	19.78	.17	.35	59.96	131.28	1.32	25.20	1.87	275.06
2004	31.62	3.32	19.77	.17	.35	60.13	131.73	1.32	25.30	1.87	275.56
2005	31.76	3.32	19.78	.17	.35	60.89	133.63	1.32	25.50	1.87	278.58
					ANNUAL GROWTH RATES						
1984-1995	3.16	.00	-1.29	-.43	-1.15	1.57	1.71	.00	2.83	4.31	1.85
1995-2005	-.94	.50	.38	.18	.00	.92	.45	.11	.51	.00	.37
1984-2005	1.19	.00	-.50	-.14	-.60	1.26	1.10	.00	1.72	2.24	1.15

generators during the early 1990's, thus reducing purchased electricity. Electricity from cogenerated sources is expected to amount to 8.7 PJ in 2005 or 24 percent of total electricity requirements. These are not reported, since the primary fuels are those used to produce the steam and have already been reported in Table 5.1.2.

A major factor in determining electricity requirements is the mix of pulp furnish in the manufacture of newsprint because each pulp variety requires different levels of electricity intensity. In newsprint mills for example, kraft pulp production consumes 3.0 GJ per tonne, while stoneground and TMP consume 5.9 and 7.8 GJ per tonne respectively. Consequently, the shift toward the TMP process, and the addition of two CTMP mills, increases the electricity intensity of output.

Included in the electricity requirements are additional loads under the Turbine Turn Down, Block Recovery programs and the Industrial Electricity Rate Discount Act (Bill 28). Electricity requirements under these programs in the pulp and paper industry amounted to 2.4 PJ in 1985. The Block Recovery program expired July 31, 1985 whereas the Turbine Turndown program extends through to March 31, 1987. Additional sales of electricity, under Bill 28 are assumed to continue until 1989.

Consumption of heavy fuel oil and natural gas is required to generate steam after the mill has used all the hog fuel or pulping liquors that it can. In recent years, the coastal and kraft mills have undertaken a number of measures to reduce the amounts of purchased fuels - natural gas and

heavy fuel oil. Further, one mill has plans to reduce its natural gas requirements by 50 percent through purchased steam which has been generated by burning garbage. Another mill intends to displace heavy fuel oil with the interface material shipped between refined petroleum products in the TransMountain pipeline between Edmonton and Vancouver. These requirements (purchased steam and interface material) are included in the "other" category of Table 5.1.2. One interior mill has reduced its consumption of natural gas by about 30 percent through heat conservation in its bleach plant. Plans for the future call for the displacement of natural gas requirements with pulverized planer shavings in the lime kilns.

The natural gas requirements forecast includes recent efforts by mills to reduce their natural gas requirements through conservation measures. Partly offsetting these measures is the assumed introduction of natural gas service to Vancouver Island where natural gas will displace heavy fuel oil.

The potential for natural gas use on Vancouver Island has been reduced by recent initiatives undertaken by some mills to substitute petroleum coke for heavy fuel oil in the lime kilns. Petroleum coke not only offers a significant price advantage, it enjoys better burning characteristics and when used in the lime kilns does not present an environmental problem. While only one Island mill is currently using significant volumes of petroleum coke, discussions with the industry indicate that other mills will install petroleum coke facilities over the next two years.

The long term availability of petroleum coke is somewhat

uncertain although significant volumes are produced in Washington State, California, Montana and Alberta. In this forecast, it is assumed that natural gas will not displace petroleum coke.

Two Vancouver Island mills have conducted tests of coal in place of heavy fuel oil in the power boilers. While coal offers a distinct price advantage over heavy fuel oil, it presents problems both for the environment and the quality of kraft pulp produced, a result of sulphur and ash emmissions.

In order to reduce the contamination problem, one mill plans to use micronized coal which removes much of the ash and sulphur. These plans could involve significant capital expenditures for pulverizing equipment either by the supplier of coal or by the mill itself, thereby increasing the effective price of coal. The second mill has an electrostatic precipitator (as opposed to cyclone precipitators used by other mills for hog fuel emmission) which it claims effectively reduces the sulphur and ash contamination problem.

Lower heavy fuel oil prices should result in only one of the above mills converting to coal. Moreover, it is assumed that these requirements will not be displaced by natural gas. Consequently, the combined requirements for petroleum coke and coal are expected to grow from about 1.6 PJ in 1986 to about 3.3 PJ by 2005.

Table 5.1.3 shows the total energy and fuel requirements of the south coast kraft and newsprint mills.

TABLE 5.1.3

FORECAST OF PULP AND PAPER ENERGY REQUIREMENTS; VANCOUVER ISLAND
(INCLUDES PORT MELLON, WOODFIBRE AND POWELL RIVER)

(PETAJOULES)

YEAR	NATURAL GAS	COAL AND COKE	HEAVY FUEL OIL	L.P.G.	DIESEL FUEL OIL	HOG FUEL	PULPING LIQUORS	OTHER	ELECT.	SELF-GEN ELECTRICITY	TOTAL REQTS
1981	.00	.00	24.18	.14	.21	22.91	47.85	.00	9.80	1.89	106.99
1982	.00	.00	23.09	.13	.19	23.12	44.41	.00	10.32	1.74	103.01
1983	.00	.00	21.79	.11	.19	27.76	48.09	.00	11.05	1.93	110.93
1984	.00	.00	21.45	.14	.19	25.11	47.67	.00	10.92	1.16	106.64
1985	.00	.00	24.45	.16	.21	28.43	53.97	.00	14.14	1.86	123.22
1986	.00	1.56	22.11	.14	.17	29.48	55.97	.33	15.46	1.86	127.08
1987	.00	2.35	21.54	.12	.12	33.39	58.20	.33	13.47	1.86	131.37
1988	6.70	3.10	16.97	.11	.09	31.30	60.05	.33	13.49	1.86	134.01
1989	7.03	3.26	17.41	.11	.07	30.83	61.21	.33	13.88	1.86	135.98
1990	7.22	3.33	17.97	.11	.07	31.19	62.16	.33	14.13	1.86	138.36
1991	7.30	3.36	18.33	.11	.07	31.47	63.10	.33	14.18	1.86	140.11
1992	6.97	3.20	18.18	.12	.07	31.47	61.19	.33	15.18	1.86	138.55
1993	6.86	3.14	18.25	.12	.07	31.23	60.29	.33	15.15	1.86	137.29
1994	6.86	3.14	18.27	.12	.07	31.23	60.29	.33	15.14	1.86	137.32
1995	6.89	3.16	18.34	.12	.07	31.10	60.29	.33	15.13	1.86	137.30
1996	6.90	3.16	18.36	.12	.07	34.36	60.29	.33	15.12	1.86	140.58
1997	7.27	3.33	19.16	.12	.08	32.24	60.29	.33	15.11	1.86	139.79
1998	7.28	3.33	19.16	.12	.08	32.24	60.29	.33	15.11	1.86	139.78
1999	7.28	3.33	19.16	.12	.08	32.24	60.29	.33	15.10	1.86	139.77
2000	7.27	3.32	19.15	.12	.08	32.24	60.29	.33	15.09	1.86	139.75
2001	7.27	3.32	19.13	.12	.08	32.24	60.29	.33	15.09	1.86	139.72
2002	7.26	3.32	19.12	.12	.08	32.24	60.29	.33	15.08	1.86	139.69
2003	7.26	3.32	19.11	.12	.08	32.24	60.29	.33	15.07	1.86	139.67
2004	7.26	3.32	19.09	.12	.08	32.24	60.29	.33	15.07	1.86	139.65
2005	7.25	3.32	19.09	.12	.08	32.24	60.29	.33	15.06	1.86	139.63
					ANNUAL GROWTH RATES						
1984-1995	.00	.00	-1.41	-1.41	-8.13	1.96	2.16	.00	3.01	4.36	2.32
1995-2005	.51	.50	.40	.25	.27	.36	.00	.00	-.05	.00	.17
1984-2005	.00	.00	-.55	-.62	-4.22	1.26	1.12	.00	1.54	2.26	1.29

The natural gas requirements of Crofton, Harmac, Port Alberni, Elk Falls, and the four mills in the Vancouver Island Natural Gas Service area are included. Natural gas requirements on Vancouver Island will grow from about 6.7 PJ in 1988 to 7.2 PJ in 2005. If the use of coal and petroleum coke were to be discontinued after natural gas becomes available, natural gas requirements would amount to 10.6 PJ by 2005.

5.1.2 Wood Industry

5.1.2.1 Introduction

In British Columbia the wood products industry consists of a large number of establishments which produce sawn lumber, plywood, veneer, shingles, shakes and particle board. Much of the output of this sector is destined for the export market. For example, in 1984 about 82 percent of all softwood plywood shipments and about 99 percent of all shipments of shingles and shakes were destined for markets outside British Columbia.

5.1.2.2 Historical Profile

Figure 5.1.2 presents an historical profile of lumber production. The emergence of operations in the Interior in the early 1960's, caused a significant geographical shift in the production of lumber. Since 1974 the trend has continued as the Interior's share of provincial lumber production increased from 61 percent to 70 percent.

This industry's natural gas consumption over the past decade has significantly increased (see Figure 5.1.3), coinciding with the growth in the Interior lumber industry,

FIG 5.1.2
HISTORICAL LUMBER
PRODUCTION PROFILE

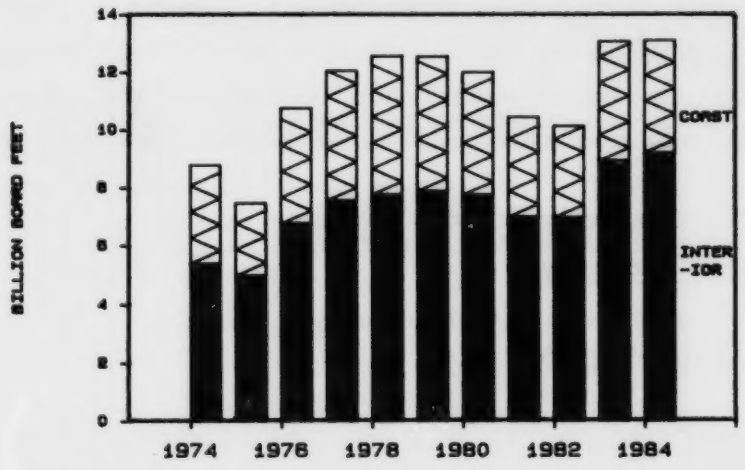
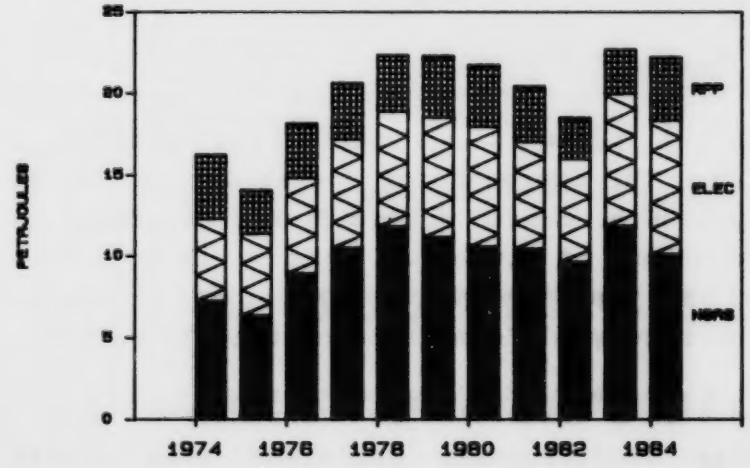


FIG 5.1.3
HISTORICAL
ENERGY REQUIREMENTS



where natural gas is used for kiln drying lumber. Kiln drying is the major source of fossil fuel requirements in sawmills: 90 percent of the lumber produced in the Interior is kiln dried compared to 44 percent on the coast. The proportion of lumber which is kiln dried has also increased.

Hog fuel is not included in the historical profile of purchased fuels presented in Figure 5.1.3. However, the Ministry estimates that 25 PJ were consumed in 1984.

Electricity consumption has increased with lumber production: its share of total energy requirements remaining near 40 percent. The share of RPP's has declined over time with the adjustment to higher oil prices and the trend to increased use of natural gas.

5.1.2.3 Forecast Period Assumptions

Industry Production

As noted in Table 5.1.4 provincial lumber production reached record levels of above 13 billion board feet in 1983, 1984 and 1985 as United States housing starts rebounded from 1 million units in 1982 to above 1.7 million units. Notwithstanding pressures in the United States to restrict softwood lumber imports, lumber production for 1986 and 1987 is expected to continue growing as United States housing starts remain in the 1.7 million unit range.

Most of the growth in lumber production over the 1983 to 1985 period was in the Interior and this is anticipated to continue in 1986 and 1987. Potential growth in total lumber production is further buoyed by the increased availability of roundwood due to a more pessimistic longer term outlook

TABLE 5.1.4

FORECAST OF LUMBER PRODUCTION

YEAR	LUMBER PRODUCTION (BILLION BOARD FEET) COAST	INTERIOR	TOTAL	PLYWOOD SHIPMENTS (B SQ FT)	SHINGLE/ SHAKE SHIPMENTS (MM SQUARES)
1981	3.458	6.966	10.424	1.953	3.105
1982	3.167	6.943	10.109	1.654	2.920
1983	4.138	8.903	13.041	1.988	3.759
1984	3.913	9.175	13.088	1.759	4.070
1985	3.996	10.008	14.003	1.866	4.168
1986	3.846	10.209	14.055	1.869	4.183
1987	3.773	10.334	14.107	1.873	4.199
1988	3.826	10.333	14.159	1.876	4.214
1989	3.879	10.333	14.212	1.880	4.230
1990	3.975	10.290	14.264	1.883	4.246
1991	4.034	10.283	14.317	1.887	4.261
1992	4.087	10.283	14.370	1.890	4.277
1993	4.148	10.275	14.423	1.894	4.293
1994	4.204	10.272	14.476	1.897	4.309
1995	4.261	10.269	14.530	1.901	4.325
1996	4.317	10.266	14.584	1.904	4.341
1997	4.374	10.264	14.638	1.908	4.357
1998	4.431	10.261	14.692	1.911	4.373
1999	4.487	10.259	14.746	1.915	4.389
2000	4.544	10.256	14.801	1.918	4.405
2001	4.602	10.254	14.856	1.922	4.422
2002	4.659	10.251	14.911	1.926	4.438
2003	4.717	10.249	14.966	1.929	4.454
2004	4.775	10.246	15.021	1.933	4.471
2005	5.121	10.233	15.354	1.954	4.570
		ANNUAL GROWTH RATES			
1984-1995	.78	1.03	.95	.71	.55
1995-2005	1.86	-.04	.55	.28	.55
1984-2005	1.29	.52	.76	.50	.55

for plywood production. Plywood has come under severe competitive pressure from waferboard. Plywood shipments averaged about 2,300 million square feet in the late 1970's, but have only averaged 1,800 million square feet since 1981. This lower production level is expected to persist throughout the forecast period.

Over the longer term, the high levels of output for all products cannot be maintained if a rate of production consistent with a sustainable forest resource is to be achieved. Despite a forecast of United States housing starts above 1.4 million throughout the forecast period, total lumber production is assumed to be constrained by the available forest resource in the longer term. Wood sector GDP (Table 5.0.1) will increase through a higher value added component rather than through higher total output.

5.1.2.4 Total Energy and Fuel Requirements

Total energy requirements, (Table 5.1.5) increase at only 0.5 percent per year between 1984 and 2005, or from 48 to 53 PJ, due to the slow rate of growth in lumber production and the relatively high cost of energy. In the period from 1979 to 1982, lumber output fell, as did total energy requirements. While lumber output increased to higher levels in 1983, energy requirements did not rebound as strongly as the industry continued its adjustment to higher real energy prices. After 1982 total energy requirements follow the trend in output.

Historical energy consumption data exclude hog fuel, consequently part of the reduction in purchased fuel requirements has been a substitution of hog fuel for purchased fuels. Adjustments have been made for hog fuel

TABLE 5.1.5

FORECAST OF WOOD PRODUCTS INDUSTRY ENERGY REQUIREMENTS

(IN PETAJOULES)

YEAR	NATURAL GAS	COAL AND COKE	HEAVY FUEL OIL	LIGHT FUEL OIL	L,P,G,	DIESEL FUEL OIL	HOG FUEL	ELECT,	TOTAL REQTS
1981	10.414	.000	.116	.276	.751	2.244	23.816	6.623	44.240
1982	9.598	.000	.055	.143	.432	1.891	22.121	6.393	40.633
1983	13.701	.000	.067	.177	.537	2.344	21.351	6.713	44.890
1984	11.963	.000	.098	.257	.782	3.413	24.658	6.822	47.993
1985	12.362	.000	.124	.327	.994	4.337	26.391	6.895	51.430
1986	9.014	.000	.133	.352	1.069	4.668	31.905	7.067	54.208
1987	8.864	.000	.135	.355	1.079	4.710	33.362	7.208	55.713
1988	9.876	.000	.069	.124	.382	4.763	33.912	7.358	56.484
1989	9.782	.000	.066	.119	.364	4.547	34.477	7.498	56.853
1990	9.743	.000	.060	.108	.331	4.133	34.614	7.637	56.626
1991	9.670	.000	.053	.095	.292	3.643	34.612	7.750	56.115
1992	9.532	.000	.045	.081	.248	3.101	34.551	7.842	55.400
1993	9.520	.000	.046	.082	.253	3.153	34.710	7.911	55.675
1994	9.507	.000	.046	.083	.255	3.186	34.770	7.907	55.754
1995	9.494	.000	.047	.083	.256	3.195	34.760	7.882	55.717
1996	9.510	.000	.046	.083	.255	3.186	34.668	7.838	55.586
1997	9.507	.000	.046	.082	.253	3.158	34.538	7.775	55.379
1998	9.510	.000	.045	.081	.250	3.122	34.409	7.696	55.113
1999	9.517	.000	.045	.080	.247	3.083	34.228	7.602	54.802
2000	9.530	.000	.044	.079	.244	3.043	34.022	7.494	54.456
2001	9.525	.000	.044	.078	.241	3.009	33.817	7.374	54.088
2002	9.488	.000	.043	.078	.239	2.987	33.635	7.243	53.713
2003	9.465	.000	.044	.079	.243	3.039	33.491	7.103	53.464
2004	9.437	.000	.045	.080	.246	3.075	33.337	6.954	53.174
2005	9.716	.000	.045	.081	.248	3.093	32.818	6.923	52.924
				ANNUAL GROWTH RATES					
1984-1995	-2.08	.00	-6.46	-9.76	-9.65	-.80	3.17	1.32	1.37
1995-2005	.23	.00	-.43	-.24	-.32	-.32	-.57	-1.29	-.51
1984-2005	-.99	.00	-3.64	-5.35	-5.32	-.47	1.37	.07	.47

requirements in the forecast period.

Hog fuel requirements will increase as heat requirements for kiln drying grow with lumber production. However, lower natural gas prices will ensure that hog fuel requirements will not grow rapidly. Demand is forecast to grow at an average annual rate of 1.4 percent increasing hog fuel's share from 51 percent of total energy in 1984 to 62 percent in 2005.

Historical natural gas requirements have followed the pattern of lumber production in the Interior because a high proportion of lumber in that region is kiln dried. However, in recent years natural gas has been replaced by hog fuel. This trend is expected to continue over the forecast period but at a slower rate than was previously foreseen. Moreover the assumed commencement of natural gas service to Vancouver Island, will allow small amounts of RPP's to be displaced by natural gas. Natural gas requirements overall will decline only marginally from 12 PJ in 1984 to 10 PJ by 2005.

Electricity requirements closely follow the trend in total provincial lumber production through the 1984 to 1990 period. However, as real electricity prices increase from 1991 onwards, electricity requirements fall from 7.6 PJ to about 6.9 PJ by the year 2005.

The share of refined petroleum products declines through the forecast period from 9.5 percent of total energy in 1984 to 6.6 percent in the year 2005.

5.2 Primary Metals

5.2.1 Introduction

This industry consists of two large metal smelting operations and a number of smaller producers. The industry produces aluminum, lead, zinc, silver, steel, copper and other metal products. The Aluminum Company of Canada (Alcan) produces aluminum ingots in its smelter at Kitimat. The Consolidated Mining and Smelting Company (Cominco) operates the Sullivan lead/zinc mine at Kimberly and a lead/zinc smelting complex at Trail. A large proportion of production is for export to the United States and Japan.

The primary metals industry is the largest industrial consumer of electricity in the province but supplies itself from hydroelectric sources.

5.2.2 Historical Profile

Both Alcan and Cominco generate significant amounts of hydroelectricity from company owned generation facilities (about 25 PJ in 1984). Alcan has developed the Nechako Reservoir and the Kemano power-house which is rated at 813 megawatts (MW). Most of the energy from this development is used at the Kitimat smelter. In the past, Alcan has had an agreement with B.C. Hydro to provide up to 1200 gigawatt-hours (GWh) (4.3 PJ) of electricity annually on an as-needed basis. Alcan also uses some coal and petroleum coke in the production of anodes and these requirements are reported in Chapter 7.

Cominco owns two hydroelectric power plants (Brilliant and Waneta) which together supply Cominco with approximately 379 MW of electrical power annually. Cominco also consumes a substantial volume of natural gas in both its smelter and chemical operations. In the smelter operations, gas is used in the blast furnaces while in the chemical operations it is used principally as a feedstock in the production of ammonia. Cominco uses some coal and coke as a reagent in the smelting process.

The remaining companies in the primary metals sector use small volumes of all fuel types.

5.2.3 Industry Production Forecast

While there is considerable scope for growth in the primary metals industry in British Columbia, general economic recovery from the 1982 recession has been followed by continued weak demand and depressed prices for copper, lead and zinc and, more recently, aluminum. Depressed markets have forced Cominco to announce production cutbacks for 1985 and 1986. Alcan has revalued its assets downward and reduced output.

Cominco phased in the operation of its upgraded zinc smelter in 1983 with full operation in 1984. An improved longer term outlook, will require further zinc smelter expansion to take place late in the 1990's. Currently, Cominco is negotiating with the federal and provincial governments for assistance to build a new lead smelter. It is assumed that these negotiations will be successful and that the new lead smelter will come on stream in the late 1980's or early 1990's.

In January 1984, Alcan applied to the Comptroller of Water Rights for design approval of the Kemano Completion hydroelectric project, and to the Ministry of Energy, Mines and Petroleum Resources for an Energy Project Certificate for an aluminum smelter at Vanderhoof and another smelter at an unspecified location. In response to poor markets for aluminum, Alcan withdrew its application and postponed indefinitely the Kemano Completion and the proposed aluminum plant. However, Alcan's water rental agreement with the province expires in 1999, making the cost of incremental electricity requirements for a new smelter after this date substantially higher. Further, it is expected that with continued worldwide economic recovery, aluminum markets will improve leading Alcan to resume its plans for Kemano completion and its proposed smelter at Vanderhoof by 1999.

The forecast assumes that a ferro-silicon smelter complex with annual output of 50,000 tonnes, and a 100,000 tonne copper smelter located in the Highland Valley will be built by the turn of the century and will receive electrical power from B.C. Hydro.

In summary, the outlook for gross domestic product for the primary metals industry is flat in the short term. However, markets are expected to improve with the result that GDP is expected to increase from 126.9 million (1971 dollars) in 1984 to 185.0 million in 2005, an average annual growth rate of 1.8 percent.

5.2.4 Forecast of Energy and Fuels Consumption

The total energy requirements of the primary metals industry are forecast to increase from 29.3 PJ in 1984 at an average annual growth rate of 1.4 percent to 34.0 PJ in 1995 and at

a 3.7 percent per year growth rate to 48.8 PJ by 2005.

Self-generated hydroelectric consumption in the primary metal sector is predicted to grow at an average annual rate of 2.5 percent between 1984 and 2005. The self-generated hydroelectricity market share represents about 85 percent of total energy requirements throughout the forecast period. Total electricity consumption is forecast to increase from 25.5 PJ in 1984 to 29.1 PJ in 1995 and 43.6 PJ by 2005, an average annual growth rate of 2.6 percent.

Natural gas consumption is forecast to increase modestly, at an average annual growth rate of 1.2 percent from 3.6 PJ in 1984 to 4.6 PJ by 2005. The demand for refined petroleum products (RPP) is also forecast to increase modestly over time. However, their market share is very small, about 0.7 and 1.0 percent in 1984 and 2005 respectively.

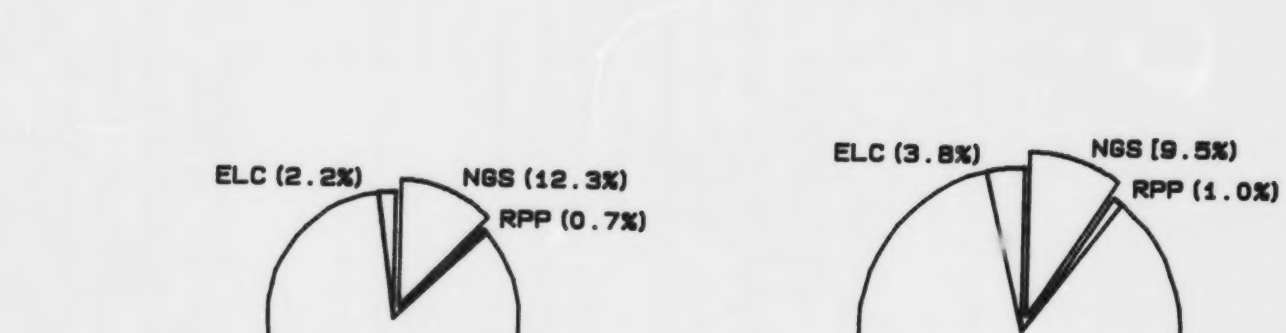
Figure 5.2.1 and Table 5.2.1 compare energy requirements by fuel type between 1984 and 2005. In the figure, NGS refers to natural gas consumption and ELC stands for electricity use.

5.3 Chemicals

5.3.1 Introduction

The chemicals industry in British Columbia produces bleaching agents for the pulp and paper industry, resins for the wood product industries, fertilizer and a range of miscellaneous chemical products for use in a variety of applications. The largest segment of demand for chemical products originates in the forest products industries.

FIGURE 5.2.1
PRIMARY METALS INDUSTRY
ENERGY REQUIREMENTS



29.2 PETAJOULES

1984

48.8 PETAJOULES

2005

TABLE 5.2.1

PRIMARY METALS INDUSTRY
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	HEAVY FUEL OIL	LIGHT FUEL OIL	DIESEL FUEL OIL	L,P,G,	ELECT,	SELF-GEN ELECTRICITY	TOTAL REQTS
1981	3.314	.083	.069	.117	.005	.630	29.218	33.436
1982	2.891	.061	.063	.101	.006	.551	26.831	30.504
1983	3.419	.062	.063	.102	.006	.613	25.436	29.701
1984	3.589	.051	.053	.085	.005	.654	24.812	29.249
1985	3.614	.037	.038	.061	.004	.696	27.080	31.530
1986	3.640	.026	.026	.043	.003	.737	26.796	31.271
1987	3.816	.027	.027	.044	.003	.779	27.711	32.407
1988	3.982	.028	.028	.046	.003	.821	27.837	32.745
1989	4.071	.028	.029	.046	.003	.862	27.963	33.002
1990	4.199	.029	.029	.047	.003	.903	28.026	33.236
1991	4.310	.029	.030	.048	.003	.991	28.026	33.437
1992	4.419	.030	.031	.049	.003	1.021	28.026	33.579
1993	4.504	.030	.031	.050	.003	1.051	28.026	33.695
1994	4.602	.031	.032	.051	.003	1.083	28.026	33.828
1995	4.696	.031	.032	.052	.003	1.115	28.026	33.955
1996	4.754	.032	.032	.052	.003	1.149	28.026	34.048
1997	4.774	.043	.044	.072	.004	1.183	29.351	35.471
1998	4.760	.064	.066	.106	.007	1.561	29.351	35.915
1999	4.747	.085	.087	.140	.009	1.597	39.755	46.420
2000	4.694	.106	.108	.174	.011	1.635	39.755	46.483
2001	4.661	.121	.123	.200	.012	1.674	41.804	48.595
2002	4.642	.123	.126	.204	.012	1.714	41.804	48.625
2003	4.631	.125	.128	.207	.013	1.755	41.804	48.663
2004	4.626	.127	.130	.210	.013	1.797	41.804	48.707
2005	4.620	.129	.132	.213	.013	1.841	41.804	48.752
				ANNUAL GROWTH RATES				
1984-1995	2.47	-4.42	-4.48	-4.37	-4.54	4.97	1.11	1.37
1995-2005	-.16	15.32	15.22	15.14	15.79	5.14	4.08	3.68
1984-2005	1.21	4.52	4.44	4.47	4.66	5.05	2.52	2.46

Therefore, the chemicals industry energy requirements are related to activity in the forest products industries.

The chemicals industry consumes natural gas and electricity. Natural gas is used in the production of resins for the wood products industries. Electricity is used primarily in the production of chemicals for the pulp and paper industry.

5.3.2 Historical Profile

There has been an upward trend in energy usage in the chemical industry since 1970. Purchases of energy have occasionally declined for reasons including strikes in the pulp and paper industry and cyclical downturns in forest products activity.

Four firms are engaged in the production of bleaching and digesting agents (chlorine, caustic soda and sodium chlorate) in British Columbia. In addition, there are three producers of resin products.

Electricity is used in the production of bleaching agents, and natural gas, refined petroleum products (RPP) and waste gases are used in raising heat for the production of resins.

5.3.3 Forecast Period Assumptions

The chemicals component of real provincial gross domestic product (GDP) is forecast to increase at an average annual rate of 2.4 percent over the 1984 to 2005 period with its share of total provinical GDP remaining at about 0.4 percent.

5.3.4 Energy and Fuel Requirements

Total energy requirements are forecast to increase at an average annual growth rate of 1.6 percent from 8.6 PJ in 1984 to 12.0 PJ in 2005. The average annual growth rate for natural gas requirements is 3.5 percent, as requirements increase from 2.6 PJ in 1984 to 5.3 PJ in 2005. The high growth rate for natural gas requirements reflects a drop in real natural gas prices and the displacement of heavy fuel oil when natural gas service on Vancouver Island is assumed to start in 1988. Electricity requirements are expected to increase slightly from 5.5 PJ in 1984 to 6.3 PJ in 2005, growing at an average annual rate of 0.6 percent.

The consumption of RPP's is forecast to decline slightly from a level of 0.49 PJ in 1984 to 0.43 PJ in 2005. Figure 5.3.1, and Table 5.3.1 compare energy requirements by fuel type between 1984 and 2005.

5.4 Non-Metallic Minerals

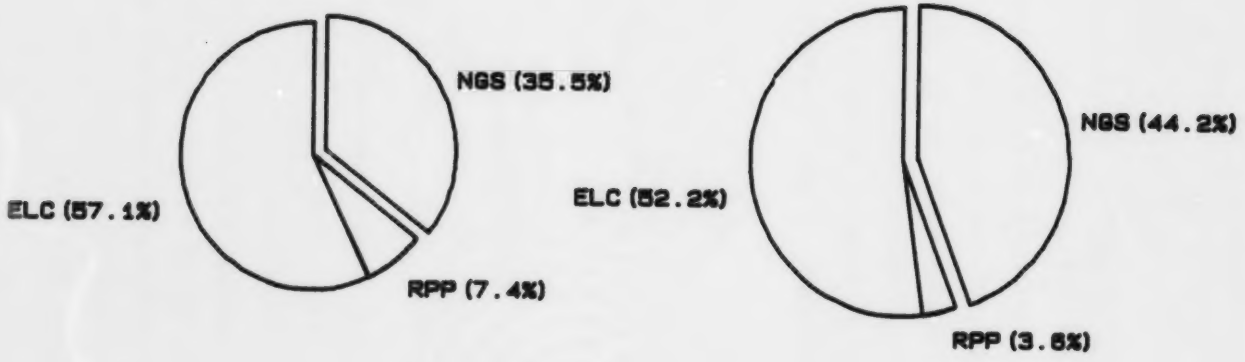
5.4.1 Introduction

This industry is dominated by cement manufacturers. The remainder of the industry is composed of glass and miscellaneous non-metallic mineral products manufacturers which consume small amounts of energy. Accordingly, the focus of this section is on the cement industry which consumes large volumes of natural gas and heavy fuel oil.

5.4.2 Historical Profile

Canada Cement Lafarge and Genstar Cement operate three cement plants in the province. Lafarge operates the

FIGURE 5.3.1
CHEMICAL INDUSTRY
ENERGY REQUIREMENTS



9.0 PETAJOULES

1984

12.0 PETAJOULES

2005

TABLE 5.3.1

FORECAST OF CHEMICALS INDUSTRY ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	COAL AND COKE	HEAVY FUEL OIL	LIGHT FUEL OIL	L.P.G.	DIESEL FUEL OIL	ELECT.	SELF-GEN ELECTRICITY	TOTAL REQTS
1981	3.17	.00	.56	.07	.00	.04	5.11	.00	8.95
1982	3.20	.00	.57	.05	.00	.03	4.33	.00	8.18
1983	2.78	.00	.43	.04	.00	.02	4.13	.00	7.40
1984	2.59	.00	.42	.04	.00	.02	5.51	.00	8.59
1985	2.55	.00	.43	.04	.00	.02	5.89	.00	8.94
1986	2.62	.00	.45	.04	.00	.02	6.19	.00	9.33
1987	2.74	.00	.47	.04	.00	.03	6.31	.00	9.58
1988	3.24	.00	.13	.05	.00	.03	6.38	.00	9.83
1989	3.42	.00	.14	.05	.00	.03	6.56	.00	10.20
1990	3.39	.00	.14	.05	.00	.03	6.59	.00	10.39
1991	3.75	.00	.15	.05	.00	.03	6.59	.00	10.57
1992	3.90	.00	.16	.05	.00	.03	6.08	.00	10.22
1993	4.03	.00	.17	.05	.00	.03	6.09	.00	10.37
1994	4.16	.00	.19	.05	.00	.03	6.09	.00	10.53
1995	4.29	.00	.20	.06	.00	.03	6.10	.00	10.68
1996	4.41	.00	.21	.06	.00	.03	6.11	.00	10.82
1997	4.52	.00	.22	.06	.00	.03	6.11	.00	10.94
1998	4.62	.00	.23	.06	.00	.03	6.12	.00	11.06
1999	4.72	.00	.25	.06	.00	.03	6.12	.00	11.18
2000	4.81	.00	.26	.06	.00	.04	6.13	.00	11.29
2001	4.90	.00	.27	.06	.00	.04	6.14	.00	11.40
2002	4.99	.00	.28	.06	.00	.04	6.14	.00	11.52
2003	5.09	.00	.29	.06	.00	.04	6.15	.00	11.64
2004	5.20	.00	.31	.07	.00	.04	6.16	.00	11.77
2005	5.32	.00	.32	.07	.00	.04	6.28	.00	12.02
				ANNUAL GROWTH RATES					
1984-1995	4.69	.00	6.63	3.17	3.75	3.05	.93	.00	2.00
1995-2005	2.17	.00	4.90	1.84	.00	1.73	.29	.00	1.19
1984-2005	3.48	.00	1.31	2.54	1.95	2.42	.63	.00	1.62

Kamloops and Richmond plants, and Genstar the Tillbury Island plant in Surrey.

There are two different technologies employed in cement manufacturing. The wet process involves the mixing of raw materials in a wet slurry which is subsequently dried. The Richmond cement plant uses this process which requires the consumption of large volumes of fossil fuels in the drying operation. The dry process involves the mixing of materials in a dry state. This process is employed at both the Kamloops and Tillbury Island plants and requires considerably less energy than the wet process. However, it does consume more electricity.

The manufacture of cement expanded considerably in the late seventies in response to United States market demand, which at that time absorbed about 63 percent of total production.

However, subsequent expansion in cement production capacity on the U.S. west coast resulted in a significant decline in exports after 1981. Recently the export market has improved as less efficient plants in the U.S. have been retired.

5.4.3 Industry Production Forecast

The forecast of cement production has been linked to economic activity in the domestic construction industry and the outlook for exports to United States markets.

The outlook for the Canadian cement industry has been improving recently as activity in both residential and non-residential construction has been increasing. Domestic cement requirements however, are not expected to be as buoyant as during the seventies. Gross domestic

product for the construction industry in British Columbia is forecast to increase at a rate of only 4.1 percent per year between 1984 and 1995, compared to an average annual growth rate during the seventies of 6.4 percent. Between 1995 and 2005, GDP in construction is expected to increase at an average rate of 3.1 percent annually.

The economic outlook for the United States is improving. Cement shipments to the United States were close to record levels in 1985 and are expected to continue in 1986. Exports of cement to the Pacific Northwest should reach 0.6 million tonnes by 1987 when British Columbia plant capacity utilization increases. After 1987, exports are forecast to increase slowly at 0.5 percent per year as growth in the United States moderates.

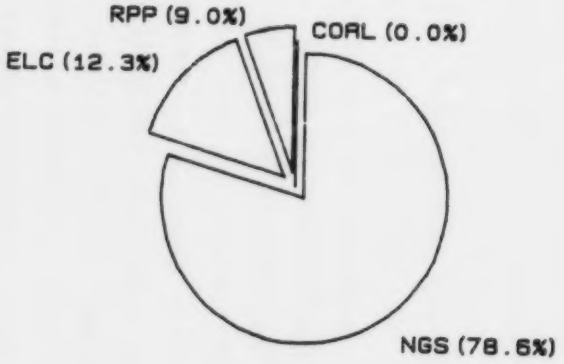
5.4.4 Forecast of Energy and Fuels Consumption

The major feature of the energy requirements forecast in the non-metallic minerals industry is the substantial shift from natural gas to coal. By 1990 coal will likely displace 85-95 percent of natural gas usage in the industry.

Coal consumption was 0.4 PJ in 1985 and is projected to increase to 8.2 PJ in 1990, and 10.5 PJ in 1995. Coal represents 62.0 percent of total energy requirements in 1995. By 2005, coal accounts for 11.0 PJ or 57.0 percent of the industry's total energy requirements (Figure 5.4.1). Natural gas (NGS) requirements are predicted to decrease from 7.3 PJ or 78.6 percent of total energy consumption in 1984 to 1.2 PJ or only 6.0 percent of total energy consumption in 2005.

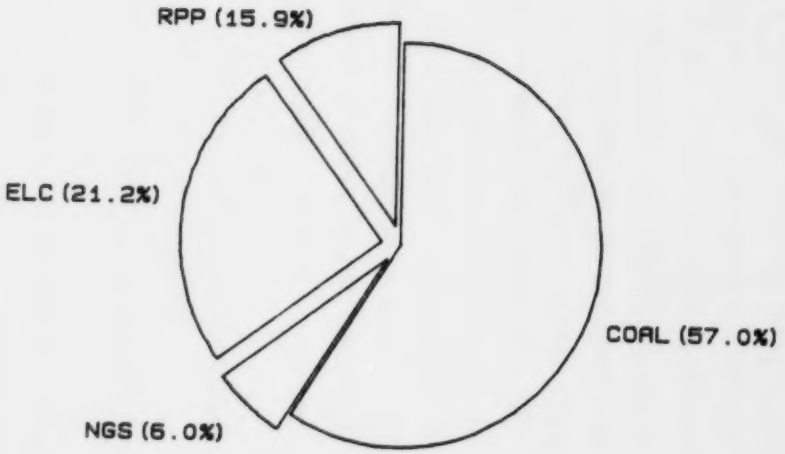
Electricity's (ELC) share of total energy is forecast to

FIGURE 5.4.1
NON-METALLIC MINERALS
ENERGY REQUIREMENTS



9.2 PETAJOULES

1984



19.3 PETAJOULES

2005

increase significantly from 1.1 PJ or 12.3 percent in 1984 to 4.1 PJ or 21.2 percent in 2005 as the Richmond plant is converted from a wet to a dry process.

The consumption of refined petroleum products (RPP) is expected to increase modestly from 9.0 percent of total energy requirements in 1984 to 15.9 percent in 2005.

Total energy consumption is forecast to increase at an average annual rate of 5.6 percent between 1984 and 1995 and about 1.3 percent between 1995 and 2005. Table 5.4.1 reports energy requirements by fuel type between 1984 and 2005.

5.5 Petroleum Refineries

5.5.1 Introduction

There are six companies operating petroleum refineries in British Columbia. Four are located in the lower mainland while the others are in Prince George and Taylor. The total capacity of these refineries is 10.2 million cubic metres per year.

The refineries process both British Columbia and Alberta crude oil and produce a wide range of products.

5.5.2 Historical Profile

Petroleum refineries in British Columbia consume three types of energy: natural gas, electricity and own-products (fuels produced in the refining process). The share of electricity has remained small and relatively constant at approximately 5 percent throughout the historical period. Ninety-five percent of refineries' energy requirements are heat require-

TABLE 5.4.1

NON-METALLIC MINERALS SECTOR
ENERGY REQUIREMENTS

(INPUT PETAJOULES)

YEAR	NATURAL GAS	COAL AND COKE	HEAVY FUEL OIL	LIGHT FUEL OIL	DIESEL FUEL OIL	L.P.G.	ELECT.	TOTAL REQTS
1981	8.046	.000	.495	.016	.663	.050	1.045	10.315
1982	5.999	.000	.414	.033	.579	.027	.975	8.027
1983	6.271	.000	.336	.027	.470	.022	.997	8.123
1984	7.268	.000	.328	.026	.459	.021	1.141	9.243
1985	5.619	.396	1.248	.101	1.749	.081	1.173	10.367
1986	1.844	4.525	1.465	.118	2.052	.095	1.282	11.381
1987	1.974	5.239	1.587	.128	2.223	.103	1.439	12.693
1988	1.753	6.120	1.521	.122	2.130	.099	1.520	13.265
1989	1.504	7.089	1.407	.113	1.971	.091	1.599	13.774
1990	1.238	8.185	1.250	.101	1.751	.081	1.687	14.293
1991	1.280	8.555	1.273	.103	1.783	.083	1.757	14.834
1992	1.315	8.877	1.297	.104	1.818	.084	1.819	15.314
1993	1.343	9.173	1.324	.107	1.855	.086	1.876	15.764
1994	1.380	9.468	1.355	.109	1.898	.088	1.934	16.232
1995	1.152	10.479	1.280	.103	1.793	.083	2.021	16.911
1996	1.163	10.668	1.268	.102	1.776	.082	2.218	17.277
1997	1.167	10.806	1.258	.101	1.762	.082	2.414	17.590
1998	1.164	10.864	1.245	.100	1.744	.081	2.599	17.797
1999	1.161	10.912	1.236	.100	1.731	.080	2.788	18.008
2000	1.158	10.951	1.229	.099	1.722	.080	2.981	18.220
2001	1.152	10.935	1.219	.098	1.708	.079	3.223	18.414
2002	1.135	10.794	1.197	.096	1.676	.078	3.573	18.549
2003	1.117	10.633	1.174	.095	1.645	.076	3.927	18.667
2004	1.133	10.799	1.189	.096	1.665	.077	3.987	18.946
2005	1.154	11.000	1.208	.097	1.692	.078	4.060	19.289
				ANNUAL GROWTH RATES				
1984-1995	-15.42	.00	13.18	13.33	13.19	13.31	5.33	5.65
1995-2005	.02	.49	-.58	-.60	-.58	-.62	7.22	1.32
1984-2005	-8.39	.00	6.40	6.47	6.41	6.45	6.23	3.57

ments met from own-products and purchased natural gas. In recent years there has been a significant shift away from own-products to natural gas. This is primarily a result of the higher market value of own-products relative to that of natural gas. Consequently, the share of natural gas increased from 3 percent in 1962 to 18 percent in 1975 and 27 percent in 1984.

The reporting of energy consumption by petroleum refineries presents conceptual difficulties, as the refinery is an industrial consumer which produces energy for the final user. The consumption of natural gas and electricity is reported as secondary energy consumption and is included in the industrial sector fuel demand. A refinery's own-product use is reported as an energy supply industry consumption used in the calculation of primary crude oil requirements and is not included in the industrial sector fuel demand.

5.5.3 Forecast Period Assumptions:

RPP Production

Since 1980, demand for RPP's has declined at a steady rate. It is expected that a moderate decline in RPP demand will be experienced until the end of the 1980's. Reduced demand for RPP's has resulted in under-utilized capacities at most British Columbia refineries. Moreover, British Columbia has become increasingly dependent on Alberta for crude oil because of declining domestic producibility. Currently, almost 80 percent of crude oil supplied to refineries in British Columbia originates in Alberta. Further, most refining companies which operate in British Columbia, except for Chevron, have larger and newer refinery facilities in Alberta. Supplying British Columbia's RPP requirement from

Alberta refining facilities would result in substantial cost reductions to refiners from improved economies of scale.

Test shipments of RPP's have been sent successfully from Edmonton to British Columbia through the TransMountain Pipeline at the instigation of three of the four companies operating in the Lower Mainland.

This forecast assumes no further expansion of refinery capacity will occur in British Columbia while allowing for the possibility of at least one refinery closure.

5.5.4 Total Energy and Fuel Requirements Forecast

Electricity demand is projected to increase slightly from 1.0 PJ in 1984 to 1.1 PJ in 2005. However, the market share of electricity is projected to increase from 4.3 percent in 1984 to 8.1 percent in 2005. (Figure 5.5.1). Consumption of natural gas is expected to decrease slightly from 6.2 PJ in 1984 to 5.7 PJ in 2005. The use of still gas is forecast to decline significantly from 11.2 PJ or 48.6 percent of total energy requirements in 1984 to only 4.6 PJ or 34.5 percent in 2005. The proportion of total energy supplied by RPP's is expected to decline from 20.1 percent in 1984 to 14.1 percent in 2005.

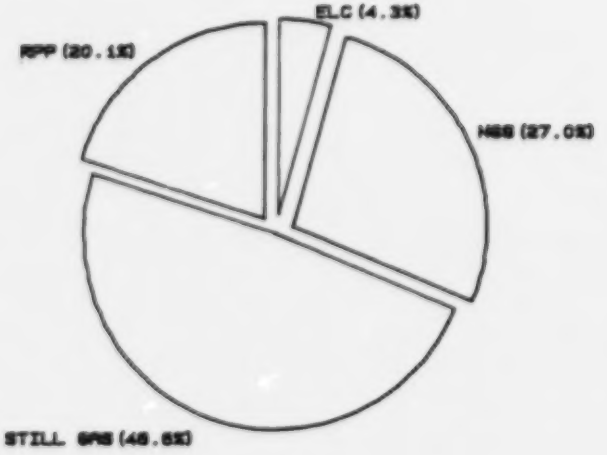
Total energy requirements, as shown in Table 5.5.1 are forecast to decrease during the forecast period from 23.1 PJ in 1984 to 13.2 in 2005.

5.6 Petrochemicals

5.6.1 Introduction

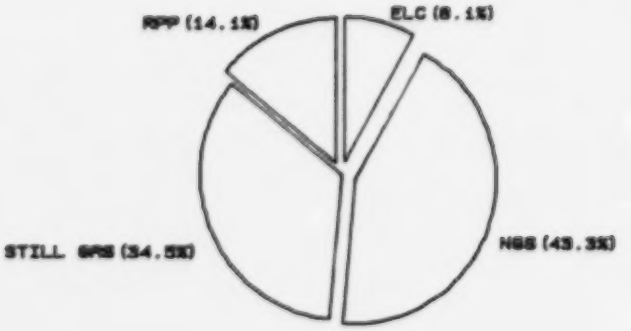
In the Ministry's last forecast this section provided an

FIGURE 5.5.1
PETROLEUM REFINERIES
ENERGY REQUIREMENTS



23.1 PETAJOULES

1984



13.2 PETAJOULES

2005

TABLE 5.5.1

PETROLEUM REFINERY SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	DIESEL FUEL OIL	HEAVY FUEL OIL	LIGHT FUEL OIL	MOTOR GASOLINE	PETROLEUM COKE	STILL GAS	TOTAL OWN-USE	NATURAL GAS	ELECT.	TOTAL REQTS
1981	.808	.530	.015	-.142	1.865	13.995	17.071	4.986	1.026	23.083
1982	.758	.947	.015	.066	1.877	10.811	14.474	5.264	.981	20.719
1983	1.620	.401	.103	.724	1.780	9.543	14.171	7.018	1.010	22.199
1984	1.686	.275	.087	.738	1.826	11.216	15.828	6.237	.995	23.060
1985	.992	.162	.051	.434	1.074	6.598	9.311	8.264	1.324	18.899
1986	1.060	.173	.055	.464	1.148	7.052	9.952	8.927	1.385	20.264
1987	1.057	.173	.055	.463	1.144	7.028	9.920	9.317	1.403	20.640
1988	1.031	.168	.053	.451	1.116	6.857	9.676	9.729	1.413	20.818
1989	.980	.160	.051	.429	1.061	6.518	9.199	9.739	1.392	20.330
1990	.975	.159	.050	.427	1.056	6.488	9.155	9.913	1.399	20.467
1991	.978	.160	.051	.428	1.059	6.507	9.183	9.929	1.401	20.513
1992	.984	.161	.051	.431	1.066	6.544	9.237	9.867	1.400	20.504
1993	.997	.163	.052	.437	1.080	6.635	9.364	9.723	1.399	20.486
1994	.917	.150	.047	.401	.993	6.098	8.606	8.857	1.322	18.785
1995	.610	.100	.032	.267	.661	4.060	5.730	6.065	1.057	12.852
1996	.647	.106	.033	.283	.701	4.306	6.076	6.297	1.084	13.457
1997	.657	.107	.034	.288	.711	4.369	6.166	6.233	1.085	13.484
1998	.665	.109	.034	.291	.720	4.420	6.239	6.130	1.083	13.452
1999	.672	.110	.035	.294	.728	4.468	6.307	6.020	1.080	13.407
2000	.679	.111	.035	.297	.736	4.517	6.375	5.917	1.078	13.370
2001	.684	.112	.035	.300	.741	4.552	6.424	5.834	1.076	13.334
2002	.686	.112	.036	.300	.743	4.566	6.443	5.785	1.075	13.303
2003	.686	.112	.036	.300	.743	4.565	6.442	5.758	1.073	13.273
2004	.687	.112	.036	.301	.744	4.568	6.448	5.744	1.073	13.265
2005	.686	.112	.036	.300	.743	4.565	6.442	5.727	1.072	13.241
					ANNUAL GROWTH RATES					
1984-1995	-8.83	-8.79	-8.69	-8.83	-8.82	-8.82	-8.82	-.25	.55	-5.18
1995-2005	1.18	1.14	1.18	1.17	1.18	1.18	1.18	-.57	.14	.30
1984-2005	-4.19	-4.19	-4.11	-4.20	-4.19	-4.19	-4.19	-.41	.36	-2.61

energy and fuel requirements forecast for three major projects in the province - Ocelot's methanol plant at Kitimat, Westcoast's proposed Ammonia Urea facility and the Canada LNG project. However, during the preparation of this forecast, Mobil Oil Canada Ltd. and Petro Canada - the key participants in the Canada LNG project - announced the cancellation of this project due to lack of agreement between Canadian and Japanese interests. It appears that the recent drop in world oil prices contributed to this decision. Following the announcement by Mobil Oil Ltd. and Petro Canada on January 28, 1986, the Canada LNG project was taken out of this forecast.

Westcoast Transmission Company had proposed to construct a nitrogen fertilizer plant in British Columbia with an in-service date of 1987. Due to market uncertainty the construction of this facility has been postponed indefinitely and is not included in the forecast.

5.6.2 Industry Production Forecast

The Ocelot plant became operational in 1982 using natural gas as a feedstock in the production of methanol. In this process hydrogen is produced as a by-product and is used in the plant as fuel. However, Ocelot intends to use this hydrogen in the production of ammonia in its expanded facility, expected to be in place by November 1986.

The plant has a contract demand for 40 MMcf per day (14.56 petajoules per year) of natural gas. At present, however the plant is running over full capacity at about 43 MMcf of gas per day (16.11 petajoules per year). It is expected that the facility will continue to have this level of demand

until the planned expansion is in operation. The demand for natural gas is then expected to increase by 4.1 petajoules to 20.21 petajoules per year.

5.6.3 Forecast of Energy Consumption

Natural gas in this industry is used principally as a feedstock which is identified as a non-energy application. Therefore natural gas requirements originating in this sector are not considered part of the overall industrial sector gas demand. Instead, the natural gas requirements for the production of petrochemicals are included in Chapter 7 which reports the non-energy demand for fuel resources. The electricity requirements are shown in Table 5.6.1.

Table 5.6.1
Petrochemical Sector
Electricity Requirements
(Petajoules)

YEAR	REQUIREMENTS
1984	.111
1985	.119
1990	.438
1995	.438
2000	.438
2005	.438
AAR(%)	6.75

Electricity demand at the Ocelot methanol plant is about 3.3 MW. With the planned expansion in 1986, this demand is expected to increase by 10.7 MW to 14.0 MW. Based on the forecast production levels, electricity requirements are expected to increase from 0.111 PJ in 1984 to 0.438 PJ in 1987. Thereafter, requirements are forecast to stay constant at the 1987 level.

5.7 Other Manufacturing

5.7.1 Introduction

This sector is defined to include all manufacturing industries not previously considered: food and beverages, rubber and plastic, clothing, textiles and leather, furniture and fixtures, printing and publishing, metal fabricating, machinery, transportation equipment and miscellaneous manufacturing.

5.7.2 Historical Profile

In 1984, "other manufacturing" accounted for 6 percent of total real GDP in B.C. and represented the largest single component (43 percent) of the total manufacturing sector. Moreover, the food and beverage industry was the largest single component of other manufacturing representing 31 percent of the total GDP generated by this subsector.

Natural gas accounted for 64 percent of energy consumption in 1984 while electricity and refined petroleum products (RPP) represented 28 and 7 percent, respectively. The food and beverage industry used 64 percent of the total energy consumed in this subsector and accounted for 67 percent of the natural gas, 78 percent of the oil, and 49 percent of the electricity consumption.

5.7.3 Forecast Period Assumptions

Industry Production

GDP for other manufacturing is forecast to grow at an average annual rate of 4.0 percent between 1984 and 1995 and

at 3.6 percent between 1995 and 2005. The food and beverage component is forecast to grow at an average annual rate of 2.7 percent between 1984 and 1995, decreasing to 2.1 percent for the rest of the forecast period. The growth rates for the non-food components are 4.5 and 4.1 percent. The growth in other manufacturing is consistent with greater use of high technology and increased industrial diversification.

5.7.4 Total Energy and Fuel Requirement Forecast

The energy requirements for this subsector are expected to follow closely the movement in GDP and relative fuel prices.

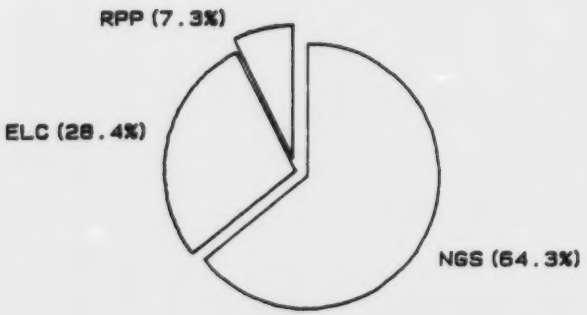
Figure 5.7.1 compares the share of energy requirements by fuel type in 1984 and 2005. Total energy requirements are predicted to increase from 11.8 PJ in 1984 to 16.4 PJ in 1995 and 21.0 PJ by 2005. This represents an average annual growth rate of 3.0 percent between 1984 and 1995 and 2.5 percent from 1995 to 2005 (see Table 5.7.1).

Natural gas is the most important fuel, with requirements rising from 7.6 PJ in 1984 (64 percent of total requirements) to 14.0 PJ in 2005 (67 percent of total requirements), indicating an average annual growth rate of 3.0 percent over the forecast period.

Electricity requirements increase from 3.4 PJ in 1984 to 6.0 PJ in 2005, an average annual increase of 2.8 percent. However, electricity requirements remain at 28 percent of total energy requirements.

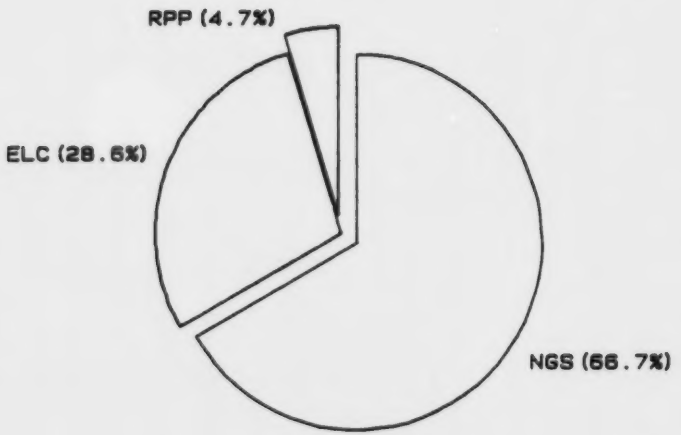
Natural gas service on Vancouver Island in 1988 will dampen demand for refined petroleum products. However declining

FIGURE 5.7.1
OTHER MANUFACTURING
ENERGY REQUIREMENTS



11.8 PETAJOULES

1984



20.9 PETAJOULES

2005

TABLE 5.7.1

OTHER MANUFACTURING SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	COAL AND COKE	HEAVY FUEL OIL	LIGHT FUEL OIL	DIESEL FUEL OIL	L.P.G.	ELECT.	TOTAL REQTS
1981	7.189	.003	.216	.204	.474	.136	3.002	11.224
1982	6.645	.003	.193	.204	.426	.122	2.959	10.552
1983	7.415	.010	.463	.153	.392	.123	3.363	11.919
1984	7.612	.008	.349	.115	.296	.093	3.356	11.829
1985	7.907	.007	.339	.111	.287	.090	3.467	12.208
1986	8.268	.008	.364	.120	.308	.097	3.633	12.798
1987	8.349	.009	.386	.130	.327	.104	3.684	12.989
1988	8.932	.004	.198	.068	.168	.054	3.777	13.201
1989	9.149	.005	.208	.073	.176	.057	3.873	13.541
1990	9.420	.005	.217	.077	.184	.060	3.991	13.954
1991	9.730	.005	.227	.082	.192	.063	4.125	14.424
1992	10.047	.005	.238	.087	.201	.066	4.263	14.907
1993	10.368	.006	.251	.092	.212	.070	4.404	15.403
1994	10.706	.006	.264	.098	.223	.074	4.552	15.923
1995	11.044	.006	.277	.104	.233	.078	4.699	16.441
1996	11.347	.007	.288	.110	.243	.082	4.832	16.909
1997	11.655	.007	.300	.116	.253	.086	4.967	17.384
1998	11.960	.007	.312	.121	.263	.090	5.101	17.854
1999	12.225	.008	.323	.127	.272	.093	5.218	18.266
2000	12.496	.008	.334	.133	.281	.097	5.338	18.687
2001	12.775	.008	.344	.139	.290	.100	5.460	19.116
2002	13.070	.009	.354	.144	.298	.104	5.588	19.567
2003	13.372	.009	.362	.150	.305	.107	5.718	20.023
2004	13.685	.009	.370	.155	.311	.110	5.853	20.493
2005	14.005	.009	.377	.159	.317	.113	5.989	20.969
				ANNUAL GROWTH RATES				
1984-1995	3.44	-2.58	-2.08	-.91	-2.15	-1.59	3.11	3.04
1995-2005	2.40	4.14	3.13	4.34	3.13	3.78	2.46	2.46
1984-2005	2.95	.56	.37	1.55	.33	.93	2.80	2.76

oil prices will tend to increase demand. Overall, demand is expected to increase slightly from 0.9 PJ in 1984 to about 1.0 PJ in 2005, an average annual rate of 0.5 percent. The RPP's share of total energy is projected to decrease from 7.3 percent in 1984 to 4.6 percent in 2005 (Figure 5.7.1). Table 5.7.1 reports energy requirements for the years 1984 to 2005.

5.8 Mining

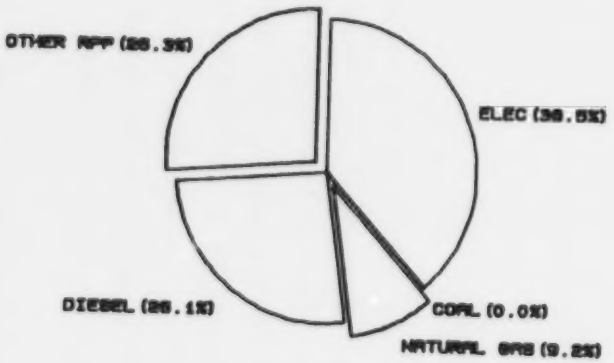
Mining in British Columbia encompasses operations producing coal, copper, lead, zinc, molybdenum, gold, silver and various other metallic and non-metallic minerals. Since the late 1960's, mining in British Columbia has been dominated by large scale open-pit coal and copper operations. Metal mines are relatively more energy intensive than coal mines. Metal mine operations require primarily electricity and diesel fuel whereas coal operations (particularly metallurgical coal) use large volumes of natural gas or refuse coal for drying purposes.

5.8.2 Historical Profile

With the emergence of open-pit coal operations since the early 1970's, natural gas requirements grew in importance as an energy source for drying coal. More recently, with the opening of coal operations in the northeast, refuse coal has been used. Natural gas accounted for only 9.2 percent of the total energy requirements for mining in 1964 but increased to 20.5 percent in 1984 (Figure 5.8.1). Coal accounted for 8.1 percent in 1984.

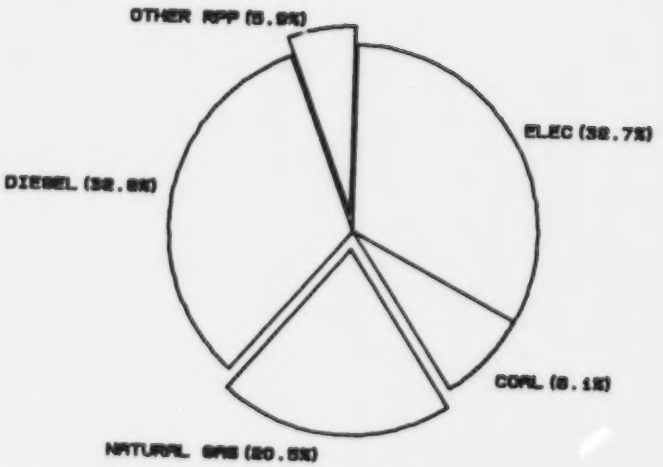
Electricity requirements grew substantially over the historical period with the opening of major copper/

FIGURE 5.8.1
MINING SECTOR
HISTORICAL ENERGY REQUIREMENTS



3.4 PETAJOULES

1964



33.0 PETAJOULES

1984

molybdenum operations in the early 1970's. Its share of total energy fell marginally from 38.5 percent of total energy requirements in 1964 to 32.7 percent in 1984.

5.8.3 Industry Production Forecast

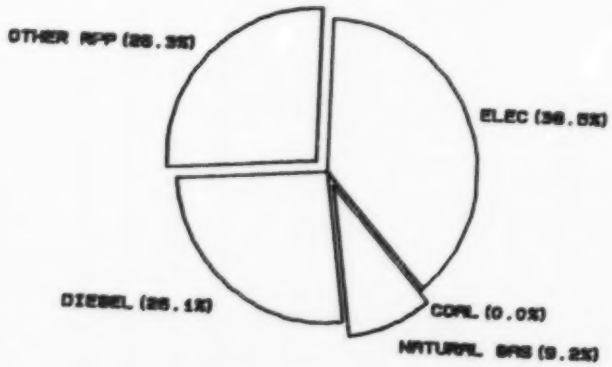
Metal mining is expected to grow at an average annual rate of 2.3 percent between 1984 and 2005. Most of this growth occurs in the last ten years of the forecast period because low metal prices will keep production depressed in the short run. This is particularly true for lead/zinc production where output remains below 1983 production levels (Table 5.8.1) until 2003.

Copper production is expected to grow at rates substantially below the 1970-1984 average of 7.9 percent per year. However, most of this growth occurred in the 1970 to 1973 period. Since then, copper production has remained depressed, and 1973 production levels will not be reached until 1988. After 1990 copper production is projected to grow at an average annual rate of 2.1 percent reaching 444 thousand tonnes in 2005. The opening of one major new mine has been forecast for the mid 1990's.

New mines, to be brought on stream after the turn of this century, will be located primarily in the northwest area of the province. These will add to total output, but will also replace the output of some currently operating mines as their ore supplies become depleted.

The production of iron ore has declined since 1965 as reserves are depleted. In 1985, production of iron ore totalled 86.6 thousand tonnes, down from 775 thousand tonnes

FIGURE 5.8.1
MINING SECTOR
HISTORICAL ENERGY REQUIREMENTS



3.4 PETAJOULES

1964

33.0 PETAJOULES

1984

molybdenum operations in the early 1970's. Its share of total energy fell marginally from 38.5 percent of total energy requirements in 1964 to 32.7 percent in 1984.

5.8.3 Industry Production Forecast

Metal mining is expected to grow at an average annual rate of 2.3 percent between 1984 and 2005. Most of this growth occurs in the last ten years of the forecast period because low metal prices will keep production depressed in the short run. This is particularly true for lead/zinc production where output remains below 1983 production levels (Table 5.8.1) until 2003.

Copper production is expected to grow at rates substantially below the 1970-1984 average of 7.9 percent per year. However, most of this growth occurred in the 1970 to 1973 period. Since then, copper production has remained depressed, and 1973 production levels will not be reached until 1988. After 1990 copper production is projected to grow at an average annual rate of 2.1 percent reaching 444 thousand tonnes in 2005. The opening of one major new mine has been forecast for the mid 1990's.

New mines, to be brought on stream after the turn of this century, will be located primarily in the northwest area of the province. These will add to total output, but will also replace the output of some currently operating mines as their ore supplies become depleted.

The production of iron ore has declined since 1965 as reserves are depleted. In 1985, production of iron ore totalled 86.6 thousand tonnes, down from 775 thousand tonnes

TABLE 5.8.1

FORECAST MINERAL PRODUCTION IN BRITISH COLUMBIA

(THOUSAND TONNES)

YEAR	COPPER	IRON ORE	LEAD/ZINC	MET. COAL	THERMAL COAL
1981	290	602	164	10898	845
1982	280	775	159	9393	2286
1983	283	497	208	9519	2449
1984	280	103	181	14236	4500
1985	302	87	181	19400	4100
1986	307	0	182	18900	6000
1987	312	0	183	19400	6000
1988	323	0	184	19700	6000
1989	318	0	185	20100	6000
1990	325	0	186	20502	6000
1991	332	0	187	20912	6000
1992	339	0	188	21330	6000
1993	346	0	189	21757	6000
1994	353	0	190	22192	6000
1995	360	0	192	22636	6000
1996	368	0	194	23089	4000
1997	376	0	195	23550	8100
1998	384	0	197	24021	8100
1999	392	0	199	24502	8100
2000	400	0	201	24992	8100
2001	408	0	203	25492	8100
2002	417	0	205	26001	8100
2003	426	0	208	26522	8100
2004	434	0	210	27052	8100
2005	444	0	212	27593	8100
			ANNUAL GROWTH RATES		
1984-1995	2.32	.00	.55	3.87	2.65
1995-2005	2.10	.00	1.00	2.00	3.05
1984-2005	2.22	.00	.76	2.56	2.84

three years earlier. No further iron ore production is expected.

The production of coal increased dramatically in 1984 with new operations in the northeast corner of the province. Total coal output jumped from 12.0 million tonnes in 1983 to 22.7 million tonnes in 1984 as the output of both metallurgical and thermal coal almost doubled. Over the period 1986-1996, the output of thermal coal is expected to remain flat due to competition from oil in Pacific Rim electric power generation. Provision has been made for an additional 2.1 million tonnes of anthracite coal from the Groundhog deposit for export to the Pacific Rim and Europe as oil prices tighten after 1995.

More growth for metallurgical coal is foreseen over the medium term. Metallurgical coal production is expected to remain almost flat until 1988 except for a slight decline in 1986. After 1988, metallurgical coal production will grow at an annual rate of 2.0 percent. Continued long term competitive pressures from other sources of supply such as Australia, South Africa and the United States and low world oil prices will continue to dampen demand.

5.8.4 Forecast of Energy and Fuels Consumption

Total energy requirements for the mining sector will grow from 33.0 PJ in 1984 to 56.6 PJ in 2005, an average annual growth rate of 2.6 percent, (see Figure 5.8.2 and Table 5.8.2).

Refuse coal consumption is expected to increase from 2.7 PJ in 1984 to 8.4 PJ in 2005, displacing some natural gas for coal drying purposes. Consequently natural gas requirements

FIGURE 5.8.2
MINING SECTOR
ENERGY REQUIREMENTS

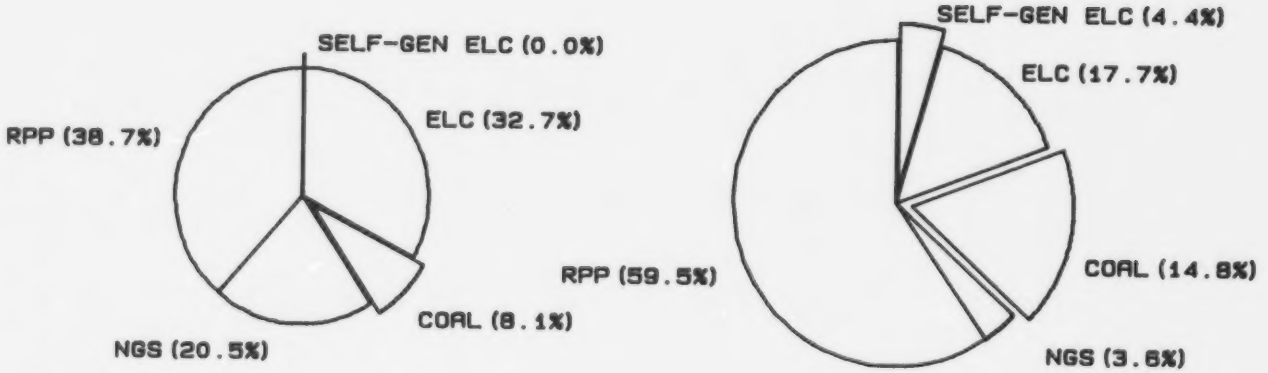


TABLE 5.8.2

MINING SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	COAL AND COKE	HEAVY FUEL OIL	LIGHT FUEL OIL	DIESEL FUEL OIL	L.P.G.	ELECT.	SELF-GEN ELECTRICITY	TOTAL REQTS
1981	6.290	.000	1.587	.211	8.973	.265	10.809	.000	28.135
1982	5.600	.000	1.124	.184	8.730	.229	10.683	.000	26.550
1983	7.081	.000	1.121	.184	8.708	.228	9.464	.000	26.786
1984	6.762	2.473	1.394	.228	10.825	.284	10.792	.000	32.958
1985	6.723	3.596	1.609	.263	12.496	.328	12.667	.000	37.682
1986	5.698	3.882	1.609	.263	12.498	.328	13.055	.000	37.333
1987	5.261	3.857	1.629	.267	12.658	.332	13.381	.000	37.385
1988	4.819	3.813	1.632	.267	12.676	.333	12.790	.000	36.330
1989	4.478	3.877	1.651	.270	12.829	.337	12.218	.000	35.660
1990	3.666	4.850	1.695	.278	13.167	.345	12.447	.000	36.448
1991	3.773	4.925	1.748	.286	13.581	.356	12.506	.000	37.175
1992	3.884	4.996	1.804	.295	14.014	.368	12.694	.000	38.055
1993	4.000	5.064	1.861	.305	14.452	.379	12.881	.000	38.942
1994	4.115	5.137	1.919	.314	14.904	.391	13.075	.000	39.855
1995	3.541	5.981	2.300	.313	17.498	.390	11.818	.000	41.841
1996	3.416	6.509	2.591	.322	19.458	.401	11.421	.000	44.118
1997	2.727	7.651	2.836	.337	21.214	.419	11.573	.000	46.757
1998	2.828	7.740	2.889	.345	21.606	.430	11.798	.000	47.436
1999	2.930	7.829	2.942	.354	22.006	.441	12.026	.000	48.528
2000	3.036	7.920	2.995	.363	22.408	.451	12.261	.000	49.434
2001	2.385	7.987	3.803	.371	23.112	.462	10.704	1.714	50.538
2002	2.017	8.073	4.331	.380	24.345	.473	9.905	2.520	52.044
2003	1.799	8.170	4.711	.390	27.066	.485	9.475	2.520	54.616
2004	1.907	8.281	4.769	.399	27.513	.497	9.734	2.520	55.620
2005	2.017	8.394	4.826	.409	27.963	.509	10.000	2.520	56.638
				ANNUAL GROWTH RATES					
1984-1995	-3.71	7.60	4.66	2.92	4.46	2.93	.83	.00	2.19
1995-2005	-5.47	3.45	7.69	2.71	4.80	2.70	-1.66	.00	3.07
1984-2005	-5.60	5.60	6.09	2.82	4.62	2.82	-.36	.00	2.61

are expected to decline from about 6.8 PJ in 1984 to 2.0 PJ by 2005.

Total electricity requirements are expected to remain flat over the forecast period except for the 1985 to 1988 period, reflecting a slow growth in mining output and high electricity prices.

Purchased electricity requirements will decline toward the end of the forecast period if the new copper and coal mines in the northwest quadrant of the province use self-generated off-grid electricity. Approximately 0.4 PJ of the electricity requirements of the northwest mines will be met by coal-fired generation and about 2.5 PJ will be met by self-generated hydro.

In the 1985 to 1988 period, purchased electricity also includes incremental sales under the B.C. Hydro Block Recovery Program and Bills 28 and 31.[1] In 1985, the combined sales in the mining sector under these programs amounted to almost 1.2 PJ. This is anticipated to peak at 1.8 PJ in 1987.

Diesel fuel requirements are anticipated to increase from 10.8 PJ in 1984 to approximately 28.0 PJ by 2005. By then, diesel requirements for generating electricity will be 8 PJ.

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1 Bill 28 is the Industrial Electricity Rate Discount Act and Bill 31 is the Critical Industries Act.

5.9 Other Industrial

5.9.1 Introduction

This sector is defined to include primary forestry (logging) and construction. Historical energy consumption for this sector was determined residually.

5.9.2 Historical Profile

Diesel fuel oil represents 80 percent of this sector's total energy consumption in 1984. Light fuel oil accounts for 5.7 percent of the total. Heavy fuel oil consumption has declined dramatically from 4.0 PJ in 1974 to about 1.3 PJ in 1984 or 9.7 percent of total energy consumption. Electricity and natural gas requirements have continued to grow modestly. However, their market share is small, about 1.2 and 3.9 percent respectively in 1984.

5.9.3 Forecast Period Assumptions

Demand for diesel fuel was forecast by analyzing requirements for logging and construction separately. Requirements for construction were assumed to grow at the same rate as GDP growth in the construction subsector (3.6 percent per year between 1984 and 2005). Logging requirements were also assumed to grow at the same rate as the output level in the logging industry -- an average annual rate of 0.9 percent between 1984 and 2005.

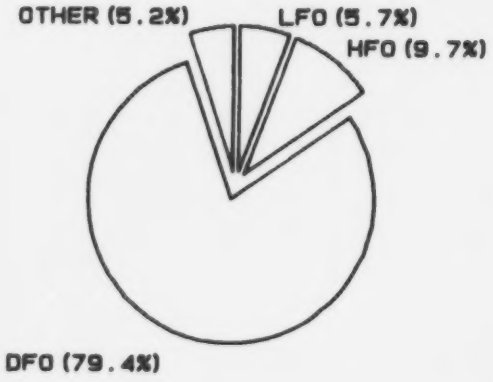
Heavy fuel oil, light fuel oil, electricity and natural gas requirements are estimated for construction and logging combined and are assumed to grow at the same rate as the combined GDP in these two subsectors.

5.9.4 Total Energy and Fuel Requirements Forecast

Total energy requirements are predicted to increase from 12.9 PJ in 1984 to 23.9 PJ in 2005, an average annual rate of 3.0 percent. This is mainly due to an expected increase in consumption of diesel fuel to 18.9 PJ in 2005, representing 79.1 percent of total energy consumption. Diesel fuel requirements are forecast to increase at an average annual rate of 3.0 percent. The consumption of heavy fuel oil and light fuel oil, are expected to grow at average annual rates of 3.0 percent between 1984 and 2005. The demand for other fuels (electricity and natural gas) is forecast to increase at a rate of 3.3 percent per year between 1989 and 2005.

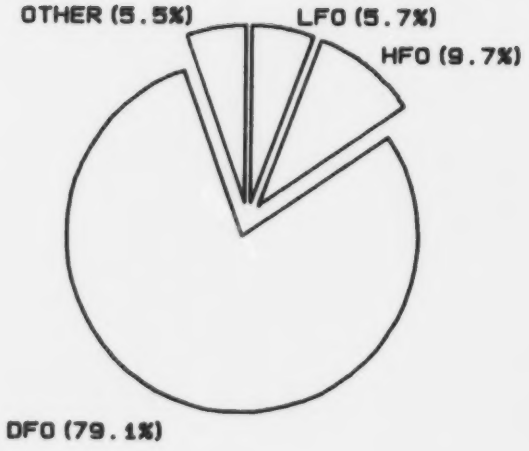
Figure 5.9.1 compares the share of energy requirements by fuel type in 1984 and 2005, and Table 5.9.1 reports energy requirements for 1984-2005.

FIGURE 5.9.1
OTHER INDUSTRIAL
ENERGY REQUIREMENTS



12.9 PETAJOULES

1984



23.9 PETAJOULES

2005

TABLE 5.9.1

OTHER INDUSTRIAL SECTOR ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	HEAVY FUEL OIL	LIGHT FUEL OIL	DIESEL FUEL OIL	ELECT.	TOTAL REQTS
1981	.677	.075	.427	16.143	.116	17.438
1982	.587	.098	.328	14.246	.101	15.360
1983	.568	.612	.757	9.302	.097	11.336
1984	.505	1.252	.734	10.207	.156	12.854
1985	.515	1.278	.749	10.419	.112	13.073
1986	.536	1.316	.772	10.731	.117	13.472
1987	.570	1.381	.810	11.258	.124	14.143
1988	.594	1.433	.840	11.685	.130	14.682
1989	.621	1.494	.876	12.182	.135	15.308
1990	.649	1.549	.908	12.631	.141	15.878
1991	.675	1.599	.937	13.034	.147	16.392
1992	.702	1.650	.967	13.453	.153	16.925
1993	.730	1.704	.999	13.888	.159	17.480
1994	.759	1.759	1.031	14.339	.165	18.053
1995	.790	1.816	1.065	14.807	.172	18.650
1996	.817	1.867	1.094	15.219	.178	19.175
1997	.846	1.919	1.125	15.645	.184	19.719
1998	.871	1.966	1.152	16.025	.190	20.204
1999	.897	2.013	1.180	16.414	.196	20.700
2000	.924	2.063	1.209	16.817	.201	21.214
2001	.952	2.111	1.238	17.212	.207	21.720
2002	.981	2.161	1.267	17.619	.214	22.242
2003	1.010	2.213	1.297	18.039	.220	22.779
2004	1.040	2.266	1.328	18.471	.227	23.332
2005	1.072	2.320	1.360	18.915	.233	23.900
			ANNUAL GROWTH RATES			
1984-1995	4.15	3.44	3.44	3.44	.89	3.44
1995-2005	3.10	2.48	2.48	2.48	3.08	2.51
1984-2005	3.65	2.98	2.98	2.98	1.93	3.00

CHAPTER 6

TRANSPORTATION SECTOR

6.0 Summary

Slower economic growth and important structural changes in the economy over the past ten years have had a dampening effect on transportation, restricting both the demand for and supply of transportation services. However, over the next two decades, the outlook for British Columbia is for increasing energy demand in the transportation sector. Average annual economic growth to 2005 of 3.2 percent, higher growth in goods producing industries (2.6 percent per year) than during the last 10 years (1.7 percent per year), continued low inflation and labour costs, and declining real fuel prices will be the major factors.

Energy demand growth in the transportation sector will be constrained due to lower than historical levels of growth for population and real personal income per capita. Moreover, depressed world prices for raw materials will favour lower-cost producers in less developed countries.

Transportation fuel demand between 1984 and 2005 is expected to increase at an average annual rate of 1.8 percent. Rail and marine transportation fuel requirements are anticipated to lead the way with a combined average annual growth rate of 3.6 percent, while auto and air transportation fuel demand is forecast to grow at only 1.5 percent annually (Tables 6.1 and 6.2).

TABLE 6.1

TOTAL TRANSPORTATION
ENERGY REQUIREMENTS
(BY MODE)

(PETAJOULES)

YEAR	ROAD	RAIL	MARINE	AIR	TOTAL REQTS
1981	178.935	10.856	44.423	25.709	259.923
1982	175.277	10.288	36.563	20.539	242.667
1983	158.835	10.535	18.480	19.126	206.976
1984	157.401	13.635	13.200	18.913	203.149
1985	163.351	13.658	12.464	20.664	210.137
1986	172.180	14.252	16.302	22.764	225.498
1987	168.796	15.134	18.833	23.536	226.299
1988	167.262	16.108	22.146	24.767	230.283
1989	165.826	16.851	22.479	25.762	230.918
1990	165.689	17.409	22.793	26.859	232.750
1991	166.583	17.934	23.134	27.605	235.256
1992	169.721	18.471	23.460	28.434	240.086
1993	172.886	18.980	24.119	29.283	245.268
1994	176.125	19.509	24.778	30.125	250.537
1995	178.522	20.088	25.563	30.955	255.128
1996	180.930	20.515	26.443	31.656	259.544
1997	183.274	20.847	27.437	32.555	264.113
1998	185.050	21.101	28.529	33.411	268.091
1999	188.125	21.309	29.703	34.260	273.397
2000	191.018	21.489	30.654	35.020	278.181
2001	194.158	21.650	31.358	35.473	282.839
2002	196.837	21.801	32.383	35.901	286.922
2003	199.388	21.946	33.100	36.321	290.755
2004	201.818	22.088	33.676	36.718	294.300
2005	203.852	22.230	34.061	36.881	297.024
		ANNUAL GROWTH RATES			
1984-1995	1.15	3.59	6.19	4.58	2.09
1995-2005	1.34	1.02	2.91	1.77	1.53
1984-2005	1.24	2.35	4.62	3.23	1.83

TABLE 6.2

TOTAL TRANSPORTATION
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS	HEAVY FUEL OIL	DIESEL FUEL OIL	MOTOR GASOLINE	L.P.G.	AVIATION GASOLINE	AVIATION TURBO	ELECT.	TOTAL REQTS
1981	.000	30.427	53.549	149.641	.421	1.357	24.352	.176	259.923
1982	.020	24.110	59.706	137.283	.829	1.009	19.530	.180	242.667
1983	.050	7.533	48.117	130.841	1.129	.972	18.154	.180	206.976
1984	.328	4.210	50.208	127.573	1.714	.939	17.974	.203	203.149
1985	.582	3.017	49.523	134.639	1.486	1.024	19.640	.226	210.137
1986	.944	5.712	52.637	141.258	1.772	1.137	21.427	.411	225.498
1987	1.301	8.367	52.361	138.247	2.058	1.045	22.491	.429	226.299
1988	1.659	11.475	53.599	136.010	2.344	1.055	23.712	.429	230.283
1989	2.011	11.485	55.295	133.298	2.630	1.066	24.696	.437	230.918
1990	2.363	11.494	57.443	131.238	2.916	1.076	25.783	.437	232.750
1991	2.715	11.534	58.670	131.010	3.202	1.087	26.518	.520	235.256
1992	3.068	11.585	60.250	132.458	3.488	1.098	27.336	.603	240.086
1993	3.420	11.625	62.262	134.219	3.774	1.109	28.174	.685	245.268
1994	3.772	11.675	64.325	135.812	4.060	1.120	29.005	.768	250.537
1995	4.124	11.733	66.573	136.774	4.118	1.131	29.824	.851	255.128
1996	4.477	11.743	68.752	137.806	4.176	1.142	30.514	.934	259.544
1997	4.829	11.753	70.921	138.794	4.235	1.154	31.401	1.026	264.113
1998	4.897	11.763	73.109	139.505	4.296	1.165	32.246	1.110	268.091
1999	4.966	11.774	75.326	141.521	4.357	1.177	33.083	1.193	273.397
2000	5.037	11.785	77.283	143.361	4.418	1.189	33.831	1.277	278.181
2001	5.108	11.796	79.162	145.538	4.481	1.201	34.272	1.281	282.839
2002	5.180	11.807	80.935	147.269	4.545	1.213	34.688	1.285	286.922
2003	5.253	11.819	82.574	148.091	4.609	1.225	35.096	1.288	290.755
2004	5.328	11.831	84.043	150.413	4.675	1.237	35.481	1.292	294.300
2005	5.403	11.843	85.294	151.566	4.741	1.249	35.632	1.296	297.024
				ANNUAL GROWTH RATES					
1984-1995	25.88	9.77	2.60	.64	8.29	1.71	4.71	13.92	2.09
1995-2005	2.74	.09	2.51	1.03	1.42	1.00	1.80	4.30	1.53
1984-2005	14.27	5.05	2.56	.82	4.96	1.37	3.31	9.23	1.83

6.1 Introduction

This chapter provides forecasts and supporting analysis of fuel use by mode of transportation (road, rail, marine and air) and fuel type. British Columbia's transportation system accounts for almost 63 percent of the province's refined petroleum product (RPP) requirement and about 26 percent of the province's total energy requirements.

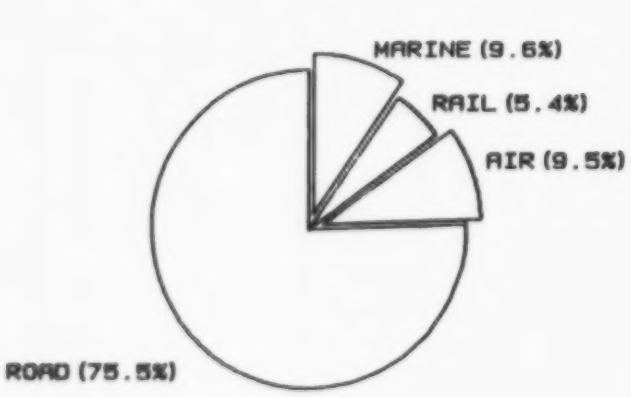
Future changes in transportation energy demand depend on changes in several economic, demographic and technology variables. Economic growth and generally lower real fuel prices are expected to cause energy demand growth in transportation starting in 1985 following a drop in demand between 1981 and 1984.

Road transportation accounted for approximately 77 percent of provincial transportation energy demand in 1984 (Figures 6.1, 6.2 and Table 6.2.1). By 2005, it is projected to account for only 69 percent.

Motor gasoline requirements, with the exception of increased requirements related to Expo 86, will continue to decline from the historical peak in 1980. Improvements in fuel efficiencies, substitution of diesel fuel and other alternatives such as propane and natural gas serve to lower demand.

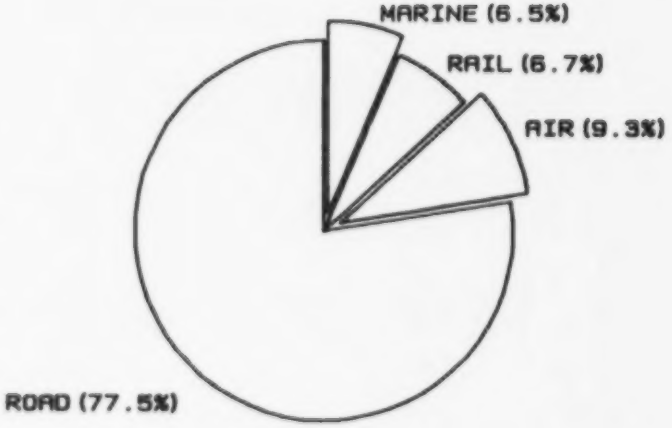
Heavy fuel oil requirements for marine bunkering are to a great extent dependent upon available supply. The 1980-1982 record high demand was caused by high producer netbacks on sales to the international market. Requirements are not

FIGURE 6.1
TRANSPORTATION ENERGY DEMAND



180 PETAJOULES

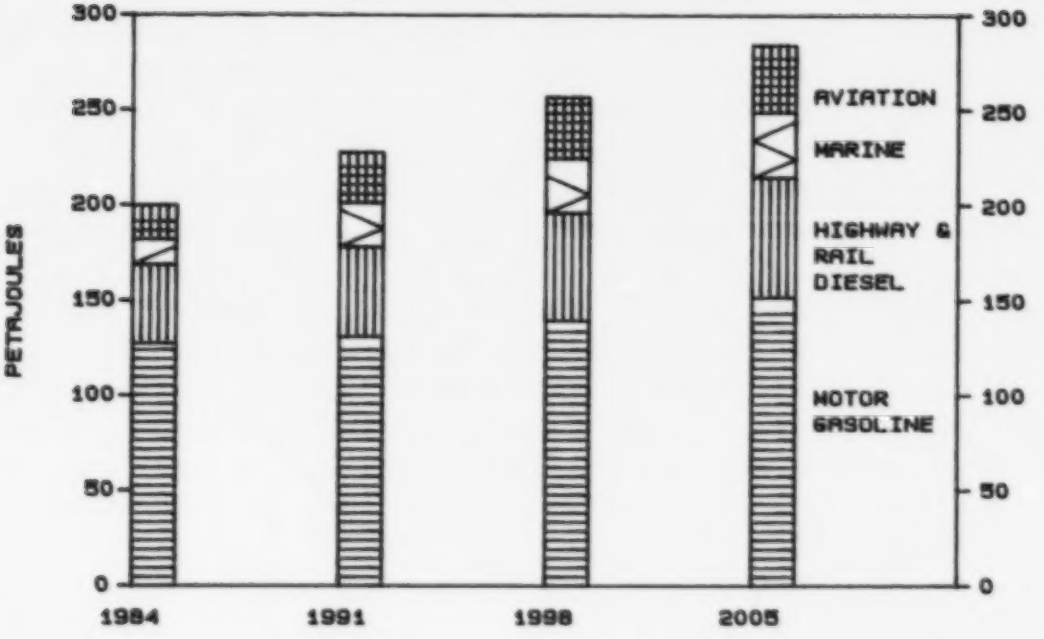
1974



203 PETAJOULES

1984

FIGURE 6.2
TRANSPORTATION ENERGY DEMAND



anticipated to reattain this level but to increase gradually from pre-1980 levels in response to increases in demand for British Columbia's export goods.

Diesel requirements are anticipated to grow gradually reflecting continued growth in automotive and trucking, rail and coastal shipping requirements.

Dramatic price increases and slower economic growth have reduced aviation fuel requirements from the 1980 peak. However, demand will still increase reflecting a gradual growth in economic activity, and forecast low and stable prices.

It is expected that an increasing trend in transportation energy demand will continue over the next 20 years.

TABLE 6.2.1

TOTAL TRANSPORTATION
ENERGY REQUIREMENTS

(MARKET SHARES)

YEAR	NATURAL GAS	HEAVY FUEL OIL	DIESEL FUEL OIL	MOTOR GASOLINE	L,P,G,	AVIATION GASOLINE	AVIATION TURBO	ELECT,	TOTAL REQTS
1981	.000	11.706	20.602	57.571	.162	.522	9.369	.068	100.000
1982	.008	9.935	24.604	56.573	.342	.416	8.048	.074	100.000
1983	.024	3.640	23.248	63.216	.545	.478	8.771	.087	100.000
1984	.161	2.072	24.715	62.798	.844	.462	8.848	.100	100.000
1985	.277	1.436	23.567	64.072	.707	.487	9.346	.108	100.000
1986	.419	2.533	21.343	62.443	.786	.504	9.591	.182	100.000
1987	.575	3.697	23.138	61.090	.909	.462	9.939	.190	100.000
1988	.720	4.983	23.275	59.062	1.018	.458	10.297	.186	100.000
1989	.871	4.974	23.946	57.725	1.139	.462	10.695	.189	100.000
1990	1.015	4.938	24.680	56.386	1.253	.462	11.078	.188	100.000
1991	1.154	4.903	24.939	55.688	1.361	.462	11.272	.221	100.000
1992	1.278	4.825	25.095	55.254	1.453	.457	11.386	.251	100.000
1993	1.394	4.740	25.385	54.723	1.539	.452	11.487	.279	100.000
1994	1.506	4.660	25.675	54.208	1.621	.447	11.577	.307	100.000
1995	1.616	4.599	26.094	53.610	1.614	.443	11.690	.334	100.000
1996	1.725	4.524	26.490	53.095	1.609	.440	11.757	.360	100.000
1997	1.828	4.450	26.853	52.551	1.603	.437	11.889	.388	100.000
1998	1.827	4.388	27.270	52.036	1.602	.435	12.028	.414	100.000
1999	1.816	4.307	27.552	51.764	1.594	.431	12.101	.436	100.000
2000	1.811	4.236	27.782	51.535	1.588	.427	12.162	.459	100.000
2001	1.806	4.171	27.988	51.456	1.584	.425	12.117	.453	100.000
2002	1.805	4.115	28.208	51.327	1.584	.423	12.090	.448	100.000
2003	1.807	4.065	28.400	51.200	1.585	.421	12.071	.443	100.000
2004	1.810	4.020	28.557	51.109	1.589	.420	12.056	.439	100.000
2005	1.819	3.987	28.716	51.028	1.596	.421	11.996	.436	100.000
				ANNUAL GROWTH RATES					
1984-1995	23.30	7.52	.49	-1.43	6.07	-.38	2.56	11.58	.00
1995-2005	1.19	-1.42	.96	-.49	-.11	-.53	.26	2.72	.00
1984-2005	12.22	3.17	.72	-.98	3.00	-.45	1.46	7.27	.00

Projections of continued economic and population growth and declining real fuel prices largely drive this forecast.

The upward push on transportation demand from provincial economic and population growth is only partly offset by fuel efficiency improvement. Moderate fuel prices lessen demand for high fuel efficiency engines. Overall there will be a 46 percent increase in annual total transportation energy requirements between 1984 and 2005.

Consumption of gasoline accounted for 127.6 PJ in 1984 (63 percent of transportation requirements), and will increase to 151.6 PJ in 2005. Economic and population growth, and real fuel price decreases result in growth of 38 percent for automotive travel by 2005. The forecast for gasoline demand would be much higher without projected fuel economy improvements, conservation measures and displacement by alternative fuels.

The average on-road fuel economy of new automobiles is forecast to increase from 15.4 litres/100 km. in 1984 to 7.8 litres/100 km. in 2005. Although the technology exists to achieve higher levels of fuel economy, moderate price declines should stimulate limited interest in greater fuel efficiency improvements.

6.2 Road Sector

6.2.1 Historical Profile

During the 1960's and early 1970's, motor gasoline requirements increased dramatically, at an average annual rate of 6.4 percent. This high rate of growth reflected

increases in the stock of vehicles as well as constant real gasoline prices. Motor gasoline requirements for the road sector increased from 52 PJ in 1960 to 123 PJ by 1974.

Since 1974 the situation has changed dramatically. Gasoline requirements have grown at an average annual rate of only 0.4 percent, from 123 PJ in 1974 to 128 PJ in 1984. Real gasoline prices grew by 4.7 percent annually and were a major constraint on gasoline demand. The recent slowdown in economic growth has exacerbated the situation.

Since the oil crisis of 1973, there has been a trend toward the use of diesel-powered automobiles. Diesel requirements grew dramatically from 1973 to 1979 in response to high levels of economic growth, relative diesel price advantages over gasoline, and additions to the stocks of diesel fleets. However, as a result of the extreme slowdown in real provincial economic growth and increasing real diesel prices, road diesel requirements have shown little growth since 1979.

Diesel requirements for the road sector increased at an average annual rate of 12.4 percent from 1960 to 1979 (2.8 PJ to 25.8 PJ), but at a dramatically lower rate of only 1.4 percent annually (25.8 PJ to 27.6 PJ) from 1979 to 1984.

Alternative fuels such as propane, natural gas and electricity are being used to power a small number of vehicles in the Province. There were an estimated 25,000 vehicles operating on propane and 3,000 on natural gas in 1985. Electricity is used as an energy source for Vancouver's trolley buses and Advanced Light Rapid Transit system.

6.2.2 Forecast Period Assumptions

Transportation fuel demand equals distance traveled multiplied by fuel efficiency or economy (e.g. litres/100 km.) and depends critically on population size, personal income, and fuel cost. Motor gasoline and diesel prices are anticipated to decline in real terms over the period 1986 to 2005 (Table 6.3). The forecast of demographic and economic trends indicates a gradual, steady growth for economic indicators such as personal income, consumer prices and economic activity. Personal vehicle travel is more sensitive to fuel costs than commercial vehicle use. As population or incomes increase, vehicle travel tends to increase, and as fuel cost increases, vehicle travel tends to decrease.

The Department of Energy in Washington, D.C. sets the Corporate Average Fuel Efficiency (CAFE) standards for new

Table 6.3

Forecast Input Projections
(Average Annual Growth Rate, Percent)

Year	Real Weighted Average Gasoline & Diesel Fuel Price	Real Total Personal Disposable Income	Population	Number of Households
1984-1990	-2.5	3.1	1.2	1.4
1990-1995	-1.1	3.4	1.4	1.8
1995-2000	-0.3	3.2	1.5	1.9
2000-2005	-0.1	3.0	1.6	2.0

vehicles manufactured by General Motors, Ford and Chrysler. The standards were legislated in 1978 to ensure production of increasingly fuel efficient cars and light trucks thereby moderating petroleum demand. Future standards may be increased to further conserve oil or may be relaxed placing greater reliance on market forces. The Market Incentives Division of the U.S. Department of Energy has supplied forecasts of CAFE standards and are used to calculate estimates of average British Columbia fleet fuel economy (see Table 6.4).

Table 6.4

Passenger Car Fuel Efficiency

Year	New Cars CAFE (mpg)*	Average Fuel Economy of Provincial fleet (litres/100 km.)
1984	26.0	15.39
1985	26.0	14.53
1990	29.0	12.51
1995	32.5	10.64
2000	36.0	9.22
2005	39.5	7.81

* 1 mpg = 282 litres/100km

After adjusting for vehicles entering and leaving British Columbia, the stock of vehicles is estimated to increase at an average annual rate of 1.1 percent between 1984 and 2005 (see Table 6.5).

Table 6.5

New Car Sales and the Stock of Passenger Vehicles

Year	Sales (000)	Stock (000)
1984	76	1209
1985	90	1234
1990	93	1247
1995	110	1342
2000	121	1408
2005	130	1520

Relatively high interest rates and generally poor economic conditions led to a rapid decline in new car sales after 1980 and 1981. Lower interest rates, attractive dealer financing arrangements and the lagged effect of depressed demand over the 1982-84 period have led to high levels of new car sales in 1985-86. It is anticipated that this will not be sustained and that 1985-86 levels will not be passed until 1990. Total vehicle kilometres travelled are expected to increase 38 percent between 1984 and 2005, an average annual increase of 1.5 percent (Table 6.6).

Table 6.6

Estimated Vehicle Kilometres Travelled
(Billions)

Year	Passenger Vehicles	Truck	Total
1984	25.6	8.0	33.5
1985	24.8	7.9	32.7
1990	27.3	9.2	35.5
1995	29.7	10.0	39.7
2000	32.4	10.9	43.3
2005	34.5	11.6	46.1

6.2.3 Requirements Forecast

As reported in Table 6.7 British Columbia's road transportation energy demand is forecast to increase 30 percent from 157 PJ in 1984 to 204 PJ in 2005. The major

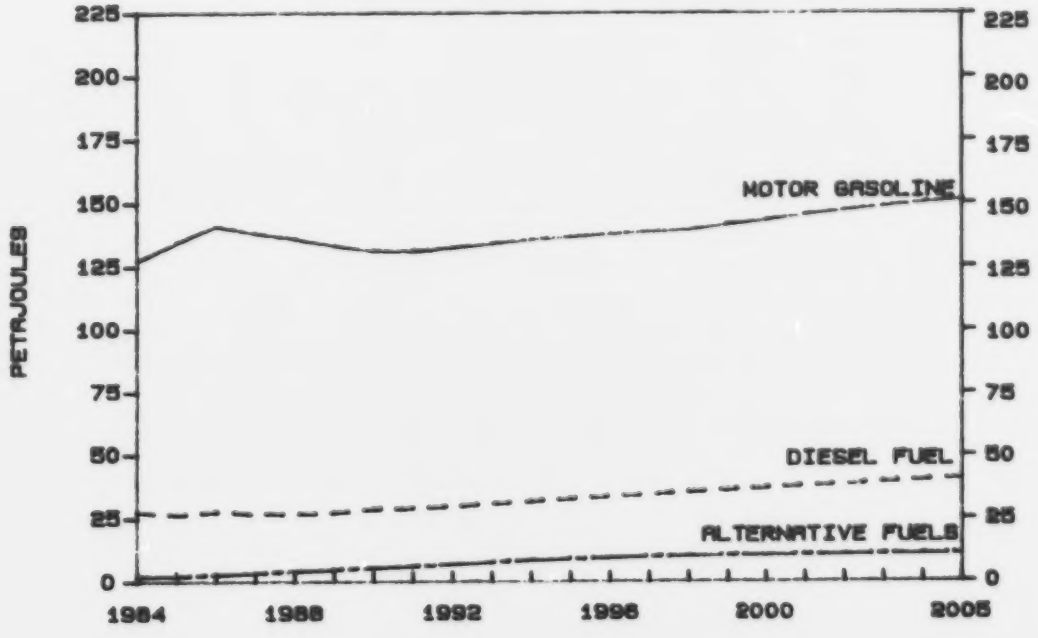
TABLE 6.7
ROAD TRANSPORT SECTOR
ENERGY REQUIREMENTS
(PETAJOULES)

YEAR	NATURAL GAS	DIESEL FUEL OIL	MOTOR GASOLINE	L.P.G.	ELECT.	TOTAL REQTS
1981	.000	28.697	149.641	.421	.176	178.935
1982	.020	36.965	137.283	.829	.180	175.277
1983	.050	26.635	130.841	1.129	.180	158.835
1984	.328	27.606	127.573	1.714	.180	157.401
1985	.582	26.464	134.639	1.486	.180	163.351
1986	.934	27.886	141.258	1.772	.330	172.180
1987	1.286	26.875	138.247	2.058	.330	168.796
1988	1.639	26.939	136.010	2.344	.330	167.262
1989	1.991	27.577	133.298	2.630	.330	165.826
1990	2.343	28.862	131.238	2.916	.330	165.689
1991	2.695	29.266	131.010	3.202	.410	166.583
1992	3.048	30.037	132.658	3.488	.490	169.721
1993	3.400	30.923	134.219	3.774	.570	172.886
1994	3.752	31.851	135.812	4.060	.650	176.125
1995	4.104	32.796	136.774	4.118	.730	178.522
1996	4.457	33.681	137.806	4.176	.810	180.930
1997	4.809	34.546	138.794	4.235	.890	183.274
1998	4.877	35.402	139.505	4.296	.970	185.050
1999	4.946	36.251	141.521	4.357	1.050	188.125
2000	5.017	37.092	143.361	4.418	1.130	191.018
2001	5.088	37.921	145.538	4.481	1.130	194.158
2002	5.160	38.733	147.269	4.545	1.130	196.837
2003	5.233	39.525	148.891	4.609	1.130	199.388
2004	5.308	40.292	150.413	4.675	1.130	201.818
2005	5.383	41.032	151.566	4.741	1.130	203.852
			ANNUAL GROWTH RATES			
1984-1995	25.82	1.58	.64	8.29	13.57	1.15
1995-2005	2.75	2.27	1.03	1.42	4.47	1.34
1984-2005	14.25	1.91	.82	4.96	9.14	1.24

factors underlying this forecast are projections of continuing economic and population growth and declining real fuel prices. Consequently, the demand for transportation services is expected to increase resulting in increased fuel requirements.

Except for an increase in fuel demand caused by Expo 86, motor gasoline demand is expected to decline gradually over the next 6 years and then to increase to a 2005 level 19 percent higher than in 1984 (Figure 6.3). Overall, road transportation energy demand is projected to grow at an average annual rate of 1.2 percent over the forecast period. This trend results from the projected growth rates of vehicle kilometers travelled (VKT) and fleet average fuel economy. The impact of VKT growth on fuel demand will be partially offset by increases in average fuel economy. It is anticipated that manufacturers will continue to make some fuel economy improvements to cars and other vehicles. As these vehicles replace older, less efficient vehicles, higher average fuel economies will be achieved.

FIGURE 6.3
ROAD TRANSPORTATION FUEL DEMAND



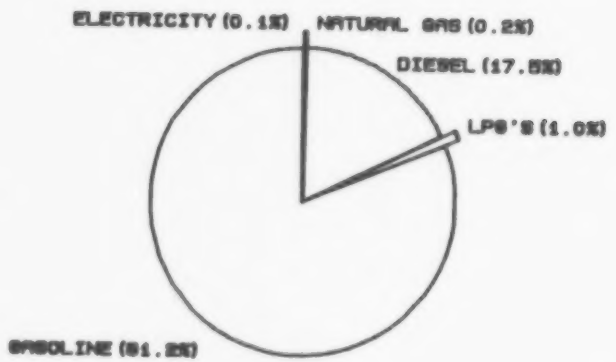
Diesel demand is projected to be 49 percent above 1984 levels by 2005. However, automobile use will decrease and light truck use will increase. Diesel car sales have recently declined, prompting General Motors to announce that it will stop producing large diesel cars. It is expected though that manufacturers will continue to make some diesel cars available.

Forecasts for LPG (propane) and natural gas requirements were determined following discussions with Energy, Mines and Resources Canada and the British Columbia Ministries of Universities, Science and Communication, and Finance. LPG and natural gas requirements as a percentage of total road requirements will increase from 1.3 percent in 1984 to 5.0 percent by 2005 (Figure 6.4).

The demand for propane is expected to increase from the 1984 level of 1.7 PJ to 4.7 PJ in 2005. Approximately 160 vehicle conversions per month, over the period 1986-1994, will be required to meet this forecast. This would bring the stock of vehicles using propane to 45,000 or 3 percent of total vehicle stock by 1994. This is assumed to be the saturation level. Propane requirements are projected to increase at the rate of increase of total road sector fuel requirements after 1994.

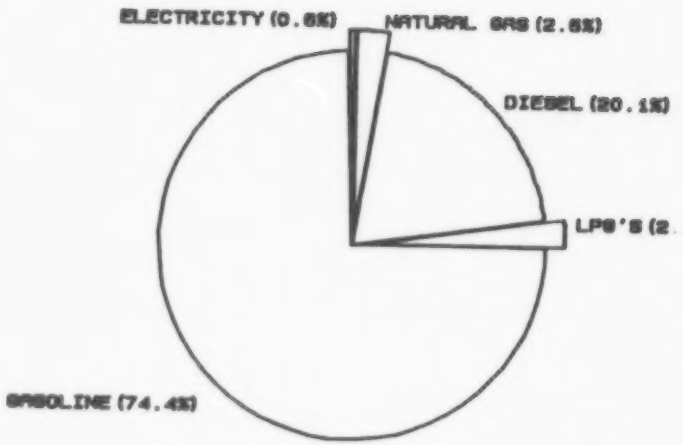
Requirements for natural gas (NGV) are expected to increase from the 1984 level of 0.3 PJ to 5.4 PJ in 2005. This would require new vehicle conversions to average approximately 230 vehicles per month between 1986 and 1997. An NGV vehicle stock of about 40,000 vehicles or 3.0 percent of the total vehicle stock is assumed to be the saturation level. This level is reached in 1997. Thereafter, NGV requirements are

FIGURE 6.4
ROAD TRANSPORTATION ENERGY DEMAND



157.4 PETAJOULES

1984



203.9 PETAJOULES

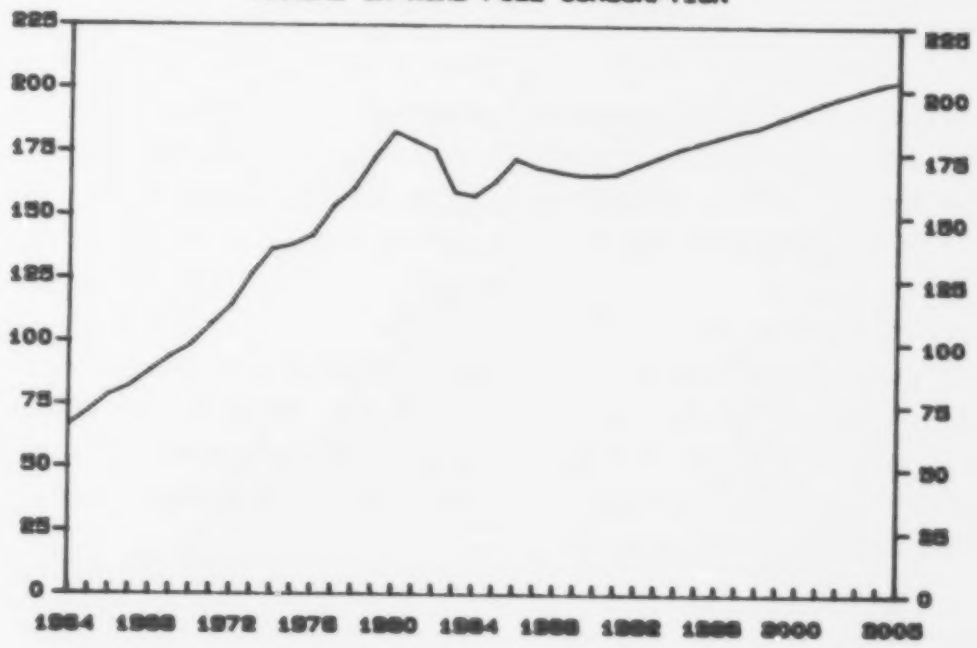
2005

projected to increase at the same rate as total road sector fuel requirements.

Electricity requirements are anticipated to grow from .18 PJ in 1984 to about 1.1 PJ by 2005. This increase in requirements reflects extensions to existing lines on the Regional District trolley system and additions to Light Rail Transit routes in Vancouver.

Figure 6.5 presents the historical and forecast level of road transport fuel use.

FIGURE 6.5
ANNUAL ON-ROAD FUEL CONSUMPTION



6.3 Rail

Energy consumption in the rail sector is principally diesel fuel used for the transport of bulk commodities, such as grain, coal and lumber. The major railways are CP Rail, CN Rail and B.C. Rail.[1] A significant portion of the diesel fuel required is purchased in Alberta and transported to fuel depots in British Columbia. However, Statistics Canada reports rail requirements in British Columbia as fuel purchased within the province only and this forecast follows that definition.

In 1984, B.C. Rail opened an electrified 130 km branch line from its main line at Anzac, near Prince George, to Tumbler Ridge, to haul coal from the northeast coal fields.

6.3.1 Historical Profile

Diesel requirements increased steadily at an average annual rate of approximately 4.4 percent, from 7.3 PJ in 1970 to 13.6 PJ in 1984. The steady upward trend was interrupted temporarily only in 1974, 1975 and 1982.

The 1974 decline in requirements of 0.6 percent was attributable to a 13 percent decrease in shipments and an 11 percent increase in real fuel prices. The 1975 and 1982 declines of 16.5 and 5.5 respectively are explained by 15 and 12 percent increases in real diesel prices, and soft world raw material prices.

The rail transportation sector is recovering and adjusting

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1 B.C. Hydro Rail uses approximately 0.1 PJ of diesel fuel annually.

to the recessionary environment. Resource markets were initially perceived to be in a cyclical downturn, but it has become evident that soft markets are the result of structural changes in the world economy.

6.3.2 Forecast Period Assumptions

Forecasts of exports of grain, coal and lumber indicate a gradual, steady growth of approximately 3.6 percent per year from 1984 to 2005. The grain export forecast for the 1984 - 2000 period was prepared by Transport Canada.[2] Grain exports through B.C. ports are forecast to grow by 2.8 percent annually between 1984 and 1990 and 3.8 percent annually between 1990 and 1995. After 1995, grain exports continue to grow at a rate of 3.1 percent per year.

Coal exports include almost all the coal produced in British Columbia plus Alberta coal destined for Pacific Rim countries. Between 1984 and 2005, it is anticipated that coal exports will grow at an average rate of 4.5 percent per year, with most of this growth occurring in the late 1980's when the northeast coal development approaches full capacity.

Interior lumber production, which has been discussed in more detail in Chapter 5, is expected to remain relatively constant over the forecast period at approximately 10.3 billion board feet.

Real diesel prices are projected to decline by 2.5 percent per year through 1995 and to remain constant thereafter.

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2 Transport Canada, "Freight and Passenger Forecasts", September 1985.

6.3.3 Requirements Forecast

British Columbia rail transportation energy demand is forecast to increase at an average rate of 2.4 percent per year, growing from 13.6 PJ in 1984 to 22.2 PJ by 2005 (Figure 6.6, Table 6.8).

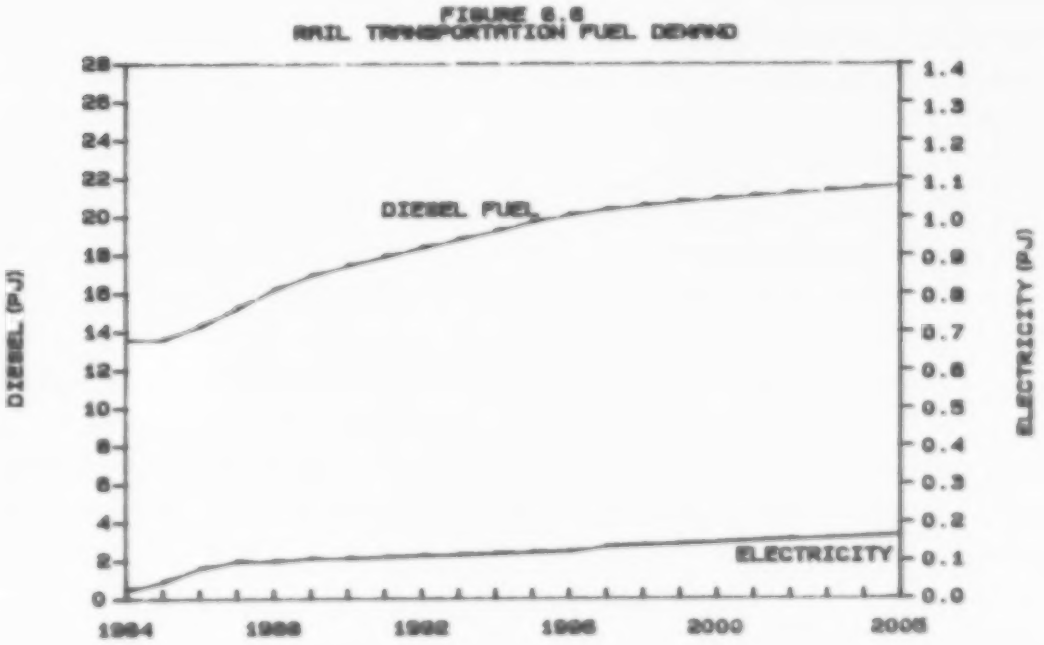


FIGURE 6.6
RAIL TRANSPORTATION FUEL DEMAND

The rate of growth of diesel requirements slows from 3.5 percent per year in the 1984 - 1995 period to 1.0 percent per year in the 1995 - 2005 period. Coal exports reach a maximum of 60.3 million metric tonnes in 1995.

Electricity requirements for hauling northeast coal will reach 0.2 PJ by 2005, up from 0.02 PJ in 1984.

TABLE 6.8

RAIL TRANSPORT SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	DIESEL FUEL OIL	ELECT.	TOTAL REQTS
1981	10.856	.000	10.856
1982	10.288	.000	10.288
1983	10.535	.000	10.535
1984	13.612	.023	13.635
1985	13.612	.046	13.658
1986	14.171	.081	14.252
1987	15.035	.099	15.134
1988	16.009	.099	16.108
1989	16.744	.107	16.851
1990	17.302	.107	17.409
1991	17.824	.110	17.934
1992	18.358	.113	18.471
1993	18.865	.115	18.980
1994	19.391	.118	19.509
1995	19.967	.121	20.088
1996	20.391	.124	20.515
1997	20.711	.136	20.847
1998	20.961	.140	21.101
1999	21.166	.143	21.309
2000	21.342	.147	21.489
2001	21.499	.151	21.650
2002	21.646	.155	21.801
2003	21.788	.158	21.946
2004	21.926	.162	22.088
2005	22.064	.166	22.230
	ANNUAL GROWTH RATES		
1984-1995	3.54	16.29	3.59
1995-2005	1.00	3.21	1.02
1984-2005	2.33	9.87	2.35

6.4 Marine

The marine sector encompasses requirements for diesel and heavy fuel oil used in domestic and international shipping operations. Domestic shipping includes marine carriers such as C.P. Ferries, Ministry of Highways' Ferries and the B.C. Ferry Corporation. Excluded from marine sector requirements are fuels used by vessels not "for-hire". Fuel use by these vessels, usually operated by oil or forest product companies, have been included in the various industrial sectors.

6.4.1 Historical Profile

Requirements for diesel fuel are determined by the coastal movement of goods, principally lumber. Slowdowns in real provincial economic growth in 1970, 1975 and 1980-1984 each contributed to declines in marine diesel requirements. The general trend in diesel requirements has been from 6.9 PJ in 1970 to 9.0 PJ in 1984.

Heavy fuel oil requirements are related to the export of bulk commodities such as grain, pulp, lumber and coal. On the west coast, sales of heavy fuel oil (HFO) have been restricted by supply. When the provincial tax structure affecting bunker netbacks was changed in 1981, oil companies diverted heavy fuel oil to eastern markets leading to a decline in British Columbia bunker sales from 30.4 PJ in 1981 to 4.2 PJ in 1984. The tax structure has since been changed and expectations are that bunker demand will return to average historical levels.

6.4.2 Forecast Period Assumptions

Heavy fuel oil and diesel prices are anticipated to decline steadily in real terms over the period to 2005 (Table 6.9).

Table 6.9
Real Price Projections
(Average Annual Growth Rate, Percent)

Year	Diesel	Heavy Fuel Oil
1984-1990	-3.7	-7.7
1990-1995	-0.9	-1.3
1995-2000	-0.1	0.1
2000-2005	0.1	0.3

Grain, coal and lumber exports are projected to grow at a rate of 3.6 percent per year and coastal lumber production at 1.3 percent per year.

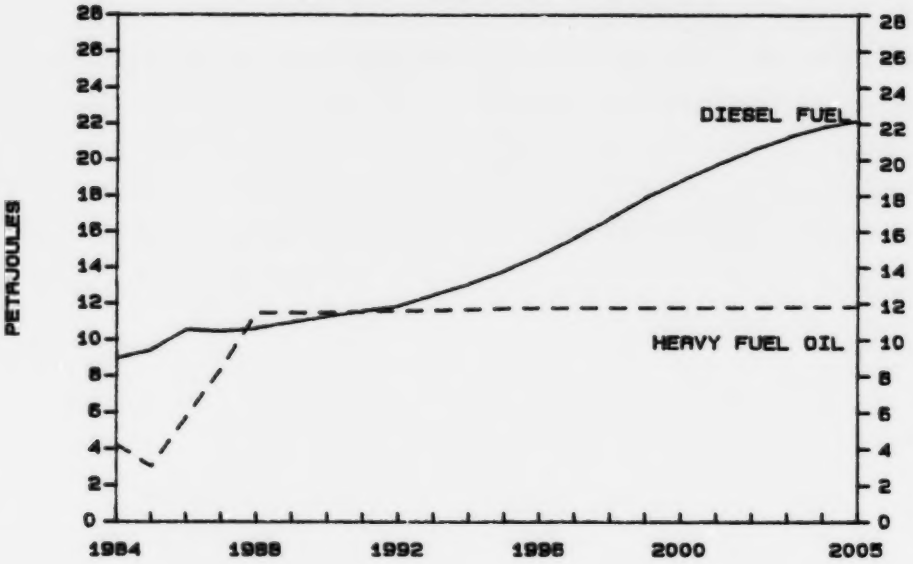
6.4.3 Requirements Forecast

Total requirements for marine transportation are forecast to increase at 4.6 percent per year, growing from 13.2 PJ in 1984 to 34.1 PJ by 2005.

The forecast projects diesel fuel requirements to increase gradually between 1984 and 2005 (Figure 6.7). The impact of Expo 86 on B.C. Ferries' diesel fuel requirement has been analyzed separately. B.C. Ferries' staff estimate that additions to the 1986 summer schedule will increase fuel consumption by 10 percent.

In January 1986, the Ministry of Transportation and Highways converted one of the Albion/Fort Langley ferries from diesel fuel to natural gas. A sister ship is expected to be converted in 1987. By 1988 natural gas requirements could total 0.02 PJ.

FIGURE 6.7
MARINE TRANSPORTATION FUEL DEMAND



Between 1990 and 2005, diesel requirements are anticipated to increase at an average annual rate of 4.6 percent, reflecting growth in coastal lumber production, continued growth in non-lumber coastal shipment activity and declining real diesel fuel prices. Overall, from 1984 to 2005, diesel requirements grow by an average annual rate of 4.4 percent reaching 22.2 PJ by 2005 (Table 6.10).

Heavy fuel oil requirements for marine bunker are consumed almost entirely by vessels engaged in the international shipment of commodities such as grain, coal and lumber. The demand for heavy fuel oil has therefore been forecast as a function of exports of these commodities and the price of heavy fuel oil in British Columbia relative to the international bunker price available on the United States west coast. The forecast projects heavy fuel oil requirements to increase to the pre-1980, historical level of 11.0 PJ by 1988 and then to grow modestly to 11.8 PJ by 2005.

TABLE 6.10

MARINE SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	HEAVY FUEL OIL	DIESEL FUEL OIL	NATURAL GAS	TOTAL REQTS
1981	30.427	13.996	.000	44.423
1982	24.110	12.453	.000	36.563
1983	7.533	10.947	.000	18.480
1984	4.210	8.990	.000	13.200
1985	3.017	9.447	.000	12.464
1986	5.712	10.580	.010	16.302
1987	8.367	10.451	.015	18.833
1988	11.475	10.651	.020	22.146
1989	11.485	10.974	.020	22.479
1990	11.494	11.279	.020	22.793
1991	11.534	11.580	.020	23.134
1992	11.585	11.855	.020	23.460
1993	11.625	12.474	.020	24.119
1994	11.675	13.083	.020	24.778
1995	11.733	13.810	.020	25.563
1996	11.743	14.680	.020	26.443
1997	11.753	15.664	.020	27.437
1998	11.763	16.746	.020	28.529
1999	11.774	17.909	.020	29.703
2000	11.785	18.849	.020	30.654
2001	11.796	19.742	.020	31.558
2002	11.807	20.556	.020	32.383
2003	11.819	21.261	.020	33.100
2004	11.831	21.825	.020	33.676
2005	11.843	22.198	.020	34.061
		ANNUAL GROWTH RATES		
1984-1995	9.77	3.98	.00	6.19
1995-2005	.09	4.86	.00	2.91
1984-2005	5.05	4.40	.00	4.62

6.5 Air

The air sector encompasses the requirements of aviation gasoline and aviation turbo fuel used for the operation of domestic and international flights and for general aviation in British Columbia.

6.5.1 Historical Profile

During the 1970's, aviation turbo fuel requirements increased dramatically at an average annual rate of 8.1 percent, from 11.3 PJ in 1970 to 24.7 PJ by 1980. By 1984 turbo fuel requirements had declined by 27.1 percent to 18.0 PJ. Significant fare increases and the 1982 recession had a major impact on passenger air travel between 1980 and 1984. Fuel prices increased at an average annual rate of 9.8 percent between 1980 and 1984. Consequently, airlines raised fares and began to phase-out fuel inefficient aircraft, and to reduce the number of flights.

Requirements for aviation gasoline remained fairly constant at approximately 1.6 PJ from 1970 to 1980, but declined 39 percent to 0.9 PJ in 1984. Consumption of aviation gasoline is for government and private aircraft. Demand was weakened by the 56 percent increase in real fuel prices over the 1980 to 1984 period.

6.5.2 Forecast Period Assumptions

Aviation turbo fuel and aviation gasoline prices are anticipated to decline 27 percent between 1984 and 1996, after which time they are forecast to increase at average rates of 0.1 percent per year.

Steady growth in income and consumer prices result in the projections reported in Table 6.11.

Table 6.11

Forecast Input Projections
Real Fuel Price, Cost of Air Travel & Number of Passengers

Year	Real Price of Aviation Turbo Fuel (1981$/GJ)	Cost of Travel (1981=100)	Number of Passengers Enplaned & Deplaned at B.C. Airports (000)
1984	9.87	1.18	6368
1985	8.71	1.20	6894
1990	7.45	1.09	8758
1995	7.20	1.08	10991
2000	7.22	1.10	13810
2005	7.29	1.12	16439

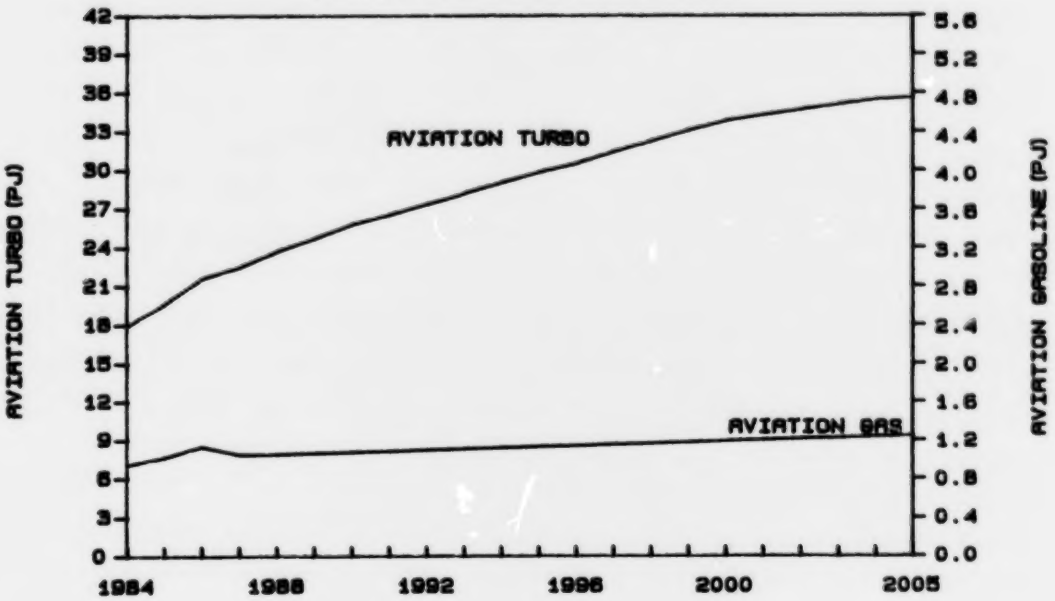
The relatively favourable outlook for economic activity and air fares reflect the beneficial impact of regulatory reform, and declining real fuel prices. On average, air travel is expected to grow 4.6 percent per year.

6.5.3 Requirements Forecast

British Columbia's total air transportation energy requirements are forecast to increase 95 percent or 3.2 percent per year, from 18.9 PJ in 1984 to 36.9 PJ by 2005. The forecast projects aviation turbo fuel requirements to increase at 4.4 percent per year from 1984 to 1997 and then to grow more slowly, at 1.6 percent per year until 2005

(Figure 6.8). The trend reflects the impact of declining real fuel prices to 1997, followed by increasing real fuel prices. Overall from 1984 to 2005, turbo fuel requirements are expected to increase 3.3 percent per year from 18.0 PJ to 35.6 PJ (Table 6.12).

FIGURE 6.8
AIR TRANSPORTATION FUEL DEMAND



Requirements for aviation gasoline are anticipated to increase at 1.4 percent per year over the 1984 to 2005 period, from 0.9 PJ to 1.2 PJ.

TABLE 6.12

AIR SECTOR
ENERGY REQUIREMENTS

(PETAJOULES)

YEAR	AVIATION GASOLINE	AVIATION TURBO	TOTAL REQTS
1981	1.357	24.352	25.709
1982	1.009	19.530	20.539
1983	.972	18.154	19.126
1984	.939	17.974	18.913
1985	1.024	19.640	20.664
1986	1.137	21.627	22.764
1987	1.045	22.491	23.536
1988	1.055	23.712	24.767
1989	1.066	24.696	25.762
1990	1.076	25.783	26.859
1991	1.087	26.518	27.605
1992	1.098	27.336	28.434
1993	1.109	28.174	29.283
1994	1.120	29.005	30.125
1995	1.131	29.824	30.955
1996	1.142	30.514	31.656
1997	1.154	31.401	32.555
1998	1.165	32.246	33.411
1999	1.177	33.083	34.260
2000	1.189	33.831	35.020
2001	1.201	34.272	35.473
2002	1.213	34.688	35.901
2003	1.225	35.096	36.321
2004	1.237	35.481	36.718
2005	1.249	35.632	36.881
	ANNUAL GROWTH RATES		
1984-1995	1.71	4.71	4.58
1995-2005	1.00	1.80	1.77
1984-2005	1.37	3.31	3.23

CHAPTER 7

NON-ENERGY USE

7.0 Introduction

This chapter provides estimates of future demand for refined petroleum products in non-energy uses. The refined petroleum products used for non-energy applications include asphalts, lubricating oils and greases and petroleum coke. Also included are natural gas requirements used as a feedstock for the petrochemical industry.

7.1 Historical Perspective

The demand for non-energy use of refined petroleum products reached its highest level in 1978 at 33.3 PJ. By 1984 requirements had dropped to 17.9 PJ, primarily due to a drop in the demand for asphalt and petroleum coke.

Historically, asphalt has constituted the major portion of non-energy requirements. It represented about 45 percent of total non-energy use in both 1978 and 1984. The demand for asphalt has declined from 15.4 PJ in 1978 to 8.0 PJ in 1984. Lubricating oils and greases' use decreased from 4.1 PJ in 1978 to 3.6 PJ in 1984. The rest of the non-energy demand includes naphtha specialties, waxes and other products, and petroleum coke. These totalled 6.3 PJ in 1984 compared to a peak of 13.7 PJ in 1978.

7.2 Forecast Period Assumptions

7.2.1 Refined Petroleum Products

The demand for refined petroleum products for non-energy use is estimated separately for asphalts and lubricating oils and greases, and for petroleum coke and other RPPs.

Asphalt is used principally for paving roads and highways, and therefore its demand depends on highway construction and repair activity, which in turn are related to the level of provincial economic activity. Newly developed substitutes, asphalt recycling, and the blending of asphalt with sulphur are expected to lower future demand.

Petroleum coke in British Columbia is used in the manufacture of anodes by Alcan. Alcan's current consumption of petroleum coke represents over 60 percent of the total provincial consumption. It is expected that this consumption will stay at the current level until new smelter capacity comes on stream in the late 1990's. With the new smelters, Alcan's production of aluminum is expected to increase by at least 75 percent to the end of the century. Currently, 63 percent of provincial demand for petroleum coke is met by imports from the United States and Alberta.

The demand for lubricating oils and greases is forecast to increase as the construction, mining and transportation and communication sectors grow. The demand for naphtha specialities and other products is forecast to grow at the same rate as the demand for asphalt, and lubricating oils and greases.

7.3 Requirements Forecast

7.3.1 Refined Petroleum Products

Total provincial demand for asphalt is expected to increase from 8.0 PJ in 1984 to 15.7 PJ in 2005, indicating an annual average growth rate of 3.3 percent.

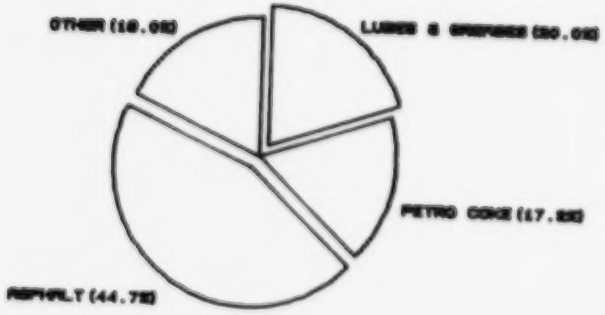
The increase in demand for petroleum coke is anticipated to come principally from the operation of new smelters by Alcan in the 1990's. Non-energy related provincial petroleum coke demand is anticipated to increase from 3.1 PJ in 1984 to 11.7 PJ by 2005, an average annual growth rate of 6.6 percent. The demand for lubricating oils and greases is forecast to increase at a rate of 2.3 percent per year from 3.6 PJ in 1984 to 5.8 PJ in 2005.

Requirements for naphtha specialties and other RPPs is forecast to grow at an annual average rate of 3.0 percent. Figure 7.1 and Table 7.1 report non-energy RPP requirements between 1984 and 2005.

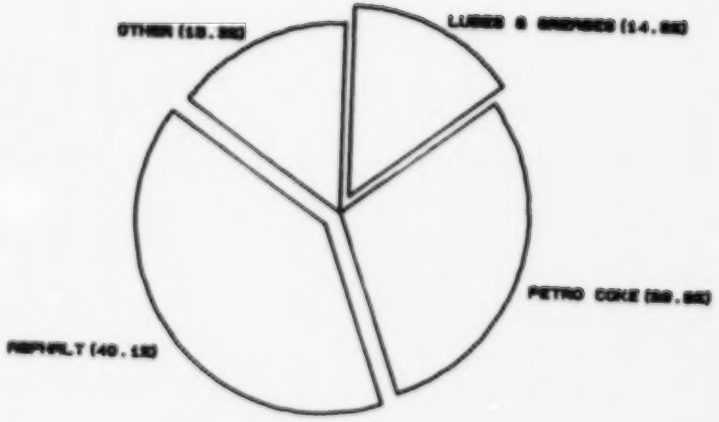
7.3.2 Feedstock Requirements

The demand for natural gas as a feedstock in the petrochemical industry is forecast to increase from 17.4 PJ in 1984 to 23.2 PJ in 2005 demonstrating an annual average growth rate of 1.4 percent over the forecast period (Table 7.2).

FIGURE 7.1
NON-ENERGY USE
ENERGY REQUIREMENTS



17.9 PETAJOULES
1984



39.2 PETAJOULES
2005

TABLE 7.1

FORECAST OF REFINED PETROLEUM PRODUCT REQUIREMENTS
FOR NON-ENERGY USE

(PETAJOULES)

YEAR	ASPHALT	LUBES AND GREASES	PETROLEUM COKE	OTHER PRODUCTS	TOTAL
1981	13.061	4.338	7.856	3.722	28.977
1982	9.372	3.919	1.606	3.106	18.003
1983	10.637	3.673	2.920	2.903	20.133
1984	8.016	3.590	3.085	3.230	17.921
1985	8.602	3.755	4.660	3.439	20.456
1986	9.156	3.842	6.283	3.617	22.898
1987	9.592	3.936	7.858	3.765	25.151
1988	9.985	4.021	7.858	3.898	25.762
1989	10.354	4.104	7.858	4.024	26.340
1990	10.706	4.205	7.858	4.150	26.919
1991	11.049	4.304	7.858	4.273	27.184
1992	11.394	4.406	7.858	4.397	28.055
1993	11.735	4.511	7.858	4.521	28.625
1994	12.074	4.617	7.858	4.645	29.194
1995	12.410	4.725	7.858	4.769	29.762
1996	12.736	4.828	7.858	4.888	30.310
1997	13.066	4.933	7.858	5.009	30.866
1998	13.395	5.035	7.858	5.129	31.417
1999	13.730	5.138	11.714	5.251	35.833
2000	14.058	5.244	11.714	5.372	36.388
2001	14.385	5.351	11.714	5.492	36.942
2002	14.718	5.458	11.714	5.615	37.505
2003	15.059	5.566	11.714	5.740	38.079
2004	15.408	5.677	11.714	5.868	38.667
2005	15.722	5.789	11.714	5.987	39.212
		ANNUAL GROWTH RATES			
1984-1995	4.05	2.53	8.87	3.61	4.72
1995-2005	2.39	2.05	4.07	2.30	2.80
1984-2005	3.26	2.30	6.56	2.98	3.80

Table 7.2
Petrochemical Feedstock Requirements
(petajoules)

YEAR	NATURAL GAS
1984	17.4
1985	18.1
1990	22.8
1995	22.9
2000	23.1
2005	23.2
ANNUAL GROWTH RATES	
1984-1995	2.5
1984-2005	1.4

CHAPTER 8

TOTAL ENERGY REQUIREMENTS

8.0 Introduction

This chapter is a summary of total end-use energy requirements in British Columbia for a 20 year period starting in 1985. In addition, demand for primary fuels in the province is presented.

End-use energy requirements included in this chapter refer to energy use in the residential, commercial, industrial and transport sectors. The primary energy demand, on the other hand, is derived from the end-use requirements by adding energy used in the energy supply industries including distribution and transmission losses. Fuel consumed in thermal generation is included in the primary energy totals, but the corresponding thermal electricity production is excluded. Primary fuel requirements are finalized by adding to primary energy totals the non-energy related consumption of refined petroleum products and the natural gas used as feedstock in the petrochemical industry.

8.1 Total End-Use Energy Requirements

Total end-use energy requirements in British Columbia are forecast to increase at an annual average rate of 1.8 percent from 784 petajoules in 1984 to 1151 petajoules in 2005. These requirements are presented by consuming sector in Table 8.1 and Figure 8.1.

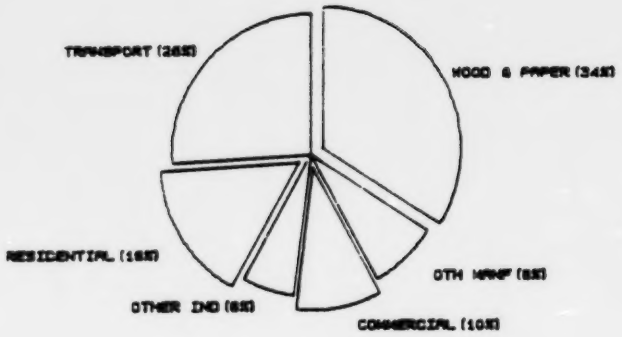
TABLE 8.1

PROVINCIAL (END-USE) ENERGY REQUIREMENTS BY SECTOR

(PETAJOULES)

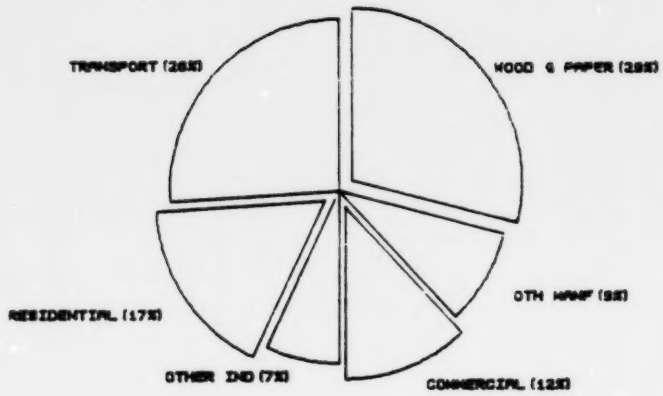
YEAR	RESIDENTIAL	COMMERCIAL	PULP AND PAPER	WOOD PRODUCTS	CHEMICALS	OTHER MAN.	MINING	PETROCHE	OTHER IND.	ROAD	AIR	MARINE	RAIL	TOTAL REQTS
1981	116.500	79.542	210.720	44.240	8.954	60.987	28.134	.000	17.438	178.934	25.710	44.424	10.856	826.439
1982	123.884	81.856	212.471	40.632	8.184	55.328	26.549	.042	15.360	175.277	20.539	36.563	10.298	806.973
1983	119.352	78.588	227.339	44.890	7.401	57.771	26.786	.094	11.336	158.835	19.126	18.480	10.535	780.533
1984	121.775	79.396	219.292	47.993	8.586	57.553	32.959	.111	12.854	157.401	18.913	13.200	13.635	783.668
1985	121.487	81.957	248.449	51.430	8.939	63.692	37.681	.119	13.074	163.350	20.664	12.464	13.658	836.964
1986	122.582	86.807	246.720	54.209	9.326	65.760	37.334	.175	13.471	172.180	22.764	16.302	14.252	861.882
1987	126.039	89.704	248.364	55.712	9.579	68.806	37.385	.438	14.142	168.796	23.536	18.833	15.134	876.468
1988	131.132	92.248	250.631	56.485	9.829	70.351	36.330	.438	14.683	167.262	24.767	22.146	16.108	892.410
1989	137.212	95.292	253.960	56.853	10.196	71.447	35.659	.438	15.309	165.826	25.762	22.479	16.851	907.284
1990	143.224	97.656	255.687	56.626	10.394	72.794	36.449	.438	15.879	165.689	26.859	22.793	17.410	921.898
1991	146.140	100.150	263.043	56.116	10.568	74.073	37.176	.438	16.392	166.584	27.605	23.134	17.934	939.303
1992	150.756	102.818	263.059	55.401	10.216	75.067	38.056	.438	16.925	169.720	28.434	23.441	18.471	952.822
1993	155.048	105.424	266.349	55.676	10.373	75.985	38.942	.438	17.479	172.886	29.282	24.119	18.980	970.981
1994	158.901	108.140	267.422	55.754	10.526	76.160	39.855	.438	18.054	176.125	30.125	24.778	19.509	985.787
1995	162.469	110.901	268.424	55.716	10.677	74.432	41.841	.438	18.650	178.521	30.955	25.564	20.088	998.676
1996	163.581	115.863	272.213	55.586	10.814	75.614	44.118	.438	19.176	180.929	31.656	26.443	20.515	1016.946
1997	167.154	120.845	271.878	55.379	10.942	77.760	46.757	.438	19.719	183.274	32.555	27.438	20.847	1034.986
1998	170.774	125.953	272.357	55.113	11.062	78.790	47.635	.438	20.204	185.050	33.412	28.530	21.101	1050.409
1999	174.002	131.268	272.788	54.803	11.180	89.792	48.529	.438	20.701	188.175	34.260	29.703	21.310	1076.899
2000	176.871	136.470	273.187	54.456	11.290	90.387	49.433	.438	21.215	191.019	35.019	30.454	21.489	1091.928
2001	179.227	137.874	274.182	54.088	11.401	93.036	50.539	.438	21.720	194.158	35.473	31.558	21.650	1105.344
2002	181.812	139.319	274.663	53.713	11.518	93.601	52.044	.438	22.241	196.837	35.901	32.383	21.801	1114.211
2003	184.800	140.728	275.063	53.464	11.639	94.184	54.614	.438	22.778	199.388	36.371	33.100	21.946	1128.463
2004	188.311	142.037	275.545	53.173	11.770	94.961	55.619	.438	23.332	201.818	36.718	33.476	22.088	1139.506
2005	191.813	142.263	278.576	52.923	12.022	95.810	56.639	.438	23.901	203.852	36.881	34.061	22.230	1151.409
							ANNUAL GROWTH RATES							
1984-1995	2.66	3.08	1.85	1.37	2.00	2.37	2.19	13.29	3.44	1.15	4.58	6.19	3.59	2.23
1995-2005	1.67	2.52	.37	-.51	1.19	2.56	3.07	.00	2.51	1.34	1.77	2.91	1.02	1.43
1984-2005	2.19	2.82	1.15	.47	1.62	2.46	2.61	6.75	3.00	1.24	3.23	4.62	2.35	1.85

FIGURE 8.1
(END USE) ENERGY REQUIREMENT BY SECTOR
(PETAJOULES)



784 PETAJOULES

1984



1151 PETAJOULES

2005

8.1.1 Energy Requirements by Sector

In 1984 the manufacturing sector accounted for about 42 percent of total (end use) energy requirements, the transport sector 26 percent, the residential sector 16 percent, the commercial sector 10 percent, and the heavy industrial sector (i.e. mining, logging and construction) the remaining 6 percent. Over the forecast period, energy requirements in the commercial and residential sectors are expected to increase at average annual rates of 2.8 and 2.2 percent, respectively. Transportation energy demand is anticipated to increase from 203 PJ in 1984 to 297 PJ by 2005, or an average annual rate of 1.8 percent. Industrial sector energy requirements are expected to grow at an average rate of 1.5 percent per year, from 379 PJ in 1984 to 521 PJ by 2005.

8.1.2 Energy Requirements by Fuel Type

Energy requirements by fuel type are summarized in Table 8.2 and Figure 8.2.

8.1.2.1 Electricity

Total provincial electricity requirements (including self-generated hydroelectricity) are forecast to increase from 144 petajoules in 1984 to 226 petajoules in 2005 indicating an annual average growth rate of 2.2 percent (Table 8.3). Self-generated hydroelectricity supplied 18 percent of total electricity demand in British Columbia in 1984, and will increase its share slightly over the forecast period.

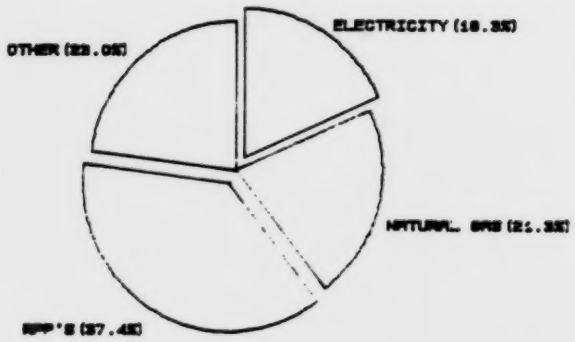
TABLE 8.2

FORECAST OF TOTAL (END-USE) FUEL REQUIREMENTS

(PETAJOULES)

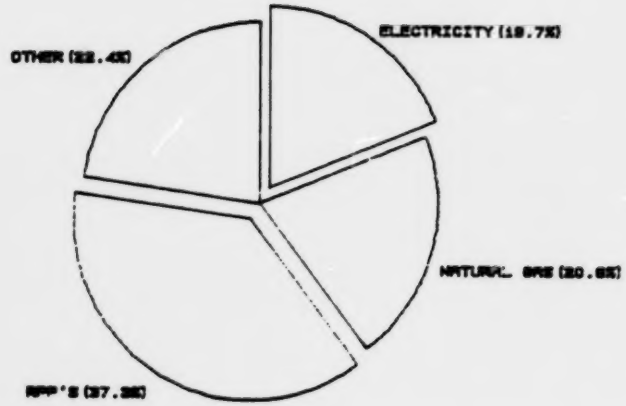
YEAR	TOTAL RPP	ELECT.	SELF-GEN ELECTRICITY	SUB-TOTAL	NATURAL GAS	OTHER	TOTAL REQTS
1981	366.377	106.959	31.107	138.066	157.186	164.810	826.439
1982	338.988	110.912	28.575	139.487	164.544	163.953	806.972
1983	293.602	112.723	27.368	140.091	166.834	180.005	780.532
1984	292.867	117.526	25.988	143.514	166.981	180.307	783.669
1985	306.839	125.464	28.951	154.415	171.688	204.021	836.963
1986	321.932	130.787	28.667	159.454	165.325	215.172	861.883
1987	324.269	131.009	29.582	160.591	169.265	222.345	876.470
1988	322.147	132.127	29.708	161.835	183.236	225.195	892.413
1989	322.725	133.426	29.834	163.260	193.277	228.021	907.283
1990	324.034	137.005	29.897	166.902	201.277	229.684	921.897
1991	327.321	138.592	29.897	168.489	208.273	235.219	939.302
1992	332.361	142.966	29.897	172.863	214.056	233.544	952.824
1993	339.120	145.878	29.897	175.775	219.113	236.974	970.982
1994	345.944	148.660	29.897	178.557	222.504	238.783	985.788
1995	354.465	149.840	29.897	179.737	222.580	241.896	998.678
1996	363.101	152.905	29.897	182.802	224.274	246.772	1016.949
1997	372.574	156.738	31.222	187.960	227.574	246.880	1034.988
1998	379.433	161.103	31.222	192.325	230.743	247.907	1050.408
1999	387.782	165.442	41.626	207.068	233.149	248.902	1076.901
2000	395.681	169.812	41.626	211.438	234.938	249.870	1091.927
2001	403.768	170.921	45.390	216.311	232.467	252.800	1105.346
2002	411.161	172.991	46.195	219.186	232.253	253.614	1116.214
2003	419.535	175.276	46.195	221.471	232.969	254.489	1128.464
2004	424.998	177.766	46.195	223.961	234.820	255.729	1139.508
2005	429.323	180.085	46.195	226.280	237.103	258.702	1151.408
			ANNUAL GROWTH RATES				
1984-1995	1.75	2.23	1.28	2.07	2.65	2.71	2.23
1995-2005	1.93	1.86	4.45	2.33	.63	.67	1.43
1984-2005	1.84	2.05	2.78	2.19	1.68	1.73	1.85

FIGURE 8.2
(END USE) ENERGY REQUIREMENT
(PETAJOULES)



784 PETAJOULES

1984



1151 PETAJOULES

2005

TABLE 8.3

PROVINCIAL ELECTRICITY REQUIREMENTS

(PETAJOULES)

YEAR	RESIDENTIAL	COMMERCIAL	PULP AND PAPER	WOOD PRODUCTS	CHEMICALS	OTHER MAN.	MINING	PETROCHE	ROAD	RAIL	SUB-TOTAL	SELF-GEN ELECTRICITY	TOTAL REQTS
1981	33.786	29.423	15.211	6.623	5.111	5.819	10.809	.000	.176	.000	106.958	31.107	138.065
1982	36.695	30.309	16.716	6.393	4.327	5.567	10.683	.042	.180	.000	110.912	28.575	139.487
1983	36.028	32.062	17.973	6.713	4.128	6.080	9.464	.094	.180	.000	112.722	27.368	140.090
1984	39.792	30.163	17.833	6.822	5.507	6.302	10.792	.111	.180	.023	117.525	25.988	143.513
1985	40.186	30.874	21.830	6.895	5.894	6.772	12.667	.119	.180	.046	125.463	28.951	154.414
1986	41.230	32.407	23.097	7.067	6.192	7.154	13.055	.175	.330	.081	130.788	28.667	159.455
1987	41.387	33.481	20.951	7.208	6.305	7.429	13.381	.438	.330	.099	131.009	29.582	160.591
1988	41.662	34.437	20.972	7.358	6.382	7.661	12.790	.438	.330	.099	132.129	29.708	161.837
1989	41.929	35.442	21.039	7.498	6.563	7.861	12.718	.438	.330	.107	133.425	29.834	163.259
1990	42.648	36.333	22.338	7.637	6.586	8.121	12.447	.438	.330	.107	137.005	29.897	166.902
1991	43.790	37.112	21.462	7.750	6.592	8.421	12.506	.438	.410	.110	138.591	29.897	168.488
1992	45.043	37.901	23.710	7.842	6.080	8.656	12.694	.438	.490	.113	142.967	29.897	172.864
1993	46.359	38.699	23.930	7.911	6.086	8.889	12.881	.438	.570	.115	145.878	29.897	175.775
1994	47.801	39.440	24.083	7.907	6.092	9.056	13.075	.438	.650	.118	148.660	29.897	178.557
1995	49.244	40.211	24.232	7.882	6.099	9.064	11.818	.438	.730	.121	149.839	29.897	179.736
1996	50.580	41.847	24.362	7.838	6.105	9.461	11.421	.438	.810	.124	152.906	29.897	182.803
1997	51.924	43.569	24.489	7.775	6.111	9.833	11.573	.438	.890	.136	156.738	31.222	187.960
1998	53.430	45.367	24.613	7.696	6.118	10.534	11.798	.438	.970	.140	161.104	31.222	192.326
1999	55.197	47.246	24.737	7.602	6.124	10.879	12.026	.438	1.050	.143	165.442	41.626	207.068
2000	57.021	49.098	24.858	7.494	6.130	11.233	12.261	.438	1.130	.147	169.810	41.626	211.436
2001	58.775	49.596	24.976	7.374	6.136	11.640	10.704	.438	1.130	.151	170.920	45.389	216.309
2002	60.681	50.043	25.089	7.243	6.143	12.164	9.905	.438	1.130	.155	172.991	46.195	219.186
2003	62.475	50.458	25.197	7.103	6.149	12.693	9.475	.438	1.130	.158	175.276	46.195	221.471
2004	64.127	50.831	25.298	6.954	6.155	12.937	9.734	.438	1.130	.162	177.766	46.195	223.961
2005	65.618	50.832	25.504	6.923	6.278	13.195	10.000	.438	1.130	.166	180.084	46.195	226.279
							ANNUAL GROWTH RATES						
1984-1995	1.96	2.65	2.83	1.32	.93	3.36	.83	13.29	13.57	16.29	2.23	1.28	2.07
1995-2005	2.91	2.37	.51	-1.29	.29	3.83	-1.66	.00	4.47	3.21	1.86	4.45	2.33
1984-2005	2.41	2.52	1.72	.07	.63	3.58	-.36	6.75	9.14	9.87	2.05	2.78	2.19

'OTHER MAN.' INCLUDES PRIMARY METALS, REFINERIES, NON-METALLIC MINERALS, AND OTHER INDUSTRIES M,E,S

Table 8.3 also shows electricity requirements by consuming sector. Commercial and residential electricity requirements are forecast to grow at annual average rates of 2.5 and 2.4 percent respectively over the 1984-2005 period. Over the same period, industrial demand for electricity is projected to grow at a relatively slow rate of 1.3 percent per year.

8.1.2.2 Natural Gas

End-use energy demand for natural gas is forecast to increase from 167 petajoules in 1984 to 237 petajoules in 2005 demonstrating an annual average growth rate of 1.7 percent (Table 8.4).

Natural gas requirements are disaggregated by consuming sector in Table 8.4. Compared to the overall natural gas growth rate of 1.4 percent per year, the residential demand for natural gas is forecast to grow at a higher rate of 1.8 percent from 63 PJ in 1984 to 92 PJ in 2005. The corresponding growth rates for commercial and industrial sectors are 3.3 percent and 0.3 percent respectively. The natural gas estimates are developed on the premise that natural gas service would be extended to Vancouver Island beginning in 1988.[1]

Demand for compressed natural gas for transportation purposes is forecast to reach a level of 5.4 petajoules by 2005.

Total (end-use) natural gas requirements for Vancouver Island are forecast to increase from 10 petajoules in 1988

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1 The natural gas estimates shown in this forecast are based on the assumption that the pipeline would follow the proposed southern route.

TABLE 8.4

PROVINCIAL NATURAL GAS REQUIREMENTS

(PETAJOULES)

YEAR	RESIDENTIAL	COMMERCIAL	PULP AND PAPER	WOOD PRODUCTS	CHEMICALS	OTHER MAN.	MINING	TRANSPORT	TOTAL REQTS
1981	55.322	30.937	26.839	10.414	3.171	24.212	6.290	.000	157.185
1982	63.626	34.107	27.010	9.598	3.198	21.386	5.600	.020	164.545
1983	61.545	31.192	25.799	13.701	2.776	24.691	7.081	.050	166.835
1984	62.801	32.530	24.793	11.963	2.592	25.211	6.762	.328	166.980
1985	64.090	33.966	25.494	12.362	2.552	25.919	6.723	.582	171.688
1986	64.232	35.987	23.619	9.014	2.616	23.215	5.698	.944	165.325
1987	66.048	37.755	23.275	8.864	2.735	24.026	5.261	1.301	169.265
1988	68.882	40.873	28.895	9.876	3.242	24.990	4.819	1.659	183.236
1989	73.884	43.881	30.740	9.782	3.419	25.084	4.478	2.011	193.279
1990	79.190	45.830	31.477	9.743	3.588	25.419	3.666	2.363	201.276
1991	80.620	47.365	34.457	9.670	3.750	25.924	3.773	2.715	208.274
1992	83.881	48.715	34.730	9.532	3.897	26.350	3.884	3.068	214.057
1993	86.677	49.649	35.147	9.520	4.032	26.668	4.000	3.420	219.113
1994	88.629	50.984	35.029	9.507	4.162	26.304	4.115	3.772	222.502
1995	90.214	52.250	34.920	9.494	4.290	23.747	3.541	4.124	222.580
1996	89.015	54.369	34.700	9.510	4.408	24.378	3.416	4.477	224.273
1997	90.129	56.277	34.913	9.507	4.517	24.675	2.727	4.829	227.574
1998	91.222	58.119	34.664	9.510	4.618	24.885	2.828	4.897	230.743
1999	91.592	60.000	34.378	9.517	4.715	25.050	2.930	4.966	233.148
2000	91.462	61.808	34.068	9.530	4.806	25.189	3.036	5.037	234.936
2001	90.852	62.003	32.323	9.525	4.897	25.374	2.385	5.108	232.467
2002	90.334	62.574	32.054	9.488	4.993	25.613	2.017	5.180	232.253
2003	90.418	63.234	31.820	9.465	5.093	25.888	1.799	5.253	232.970
2004	91.212	63.885	31.621	9.437	5.202	26.228	1.907	5.328	234.820
2005	92.242	64.072	31.760	9.716	5.315	26.578	2.017	5.403	237.103
				ANNUAL GROWTH RATES					
1984-1995	3.35	4.40	3.16	-2.08	4.69	-.54	-5.71	25.88	2.65
1995-2005	.22	2.06	-.94	.23	2.17	1.13	-5.47	2.74	.63
1984-2005	1.85	3.28	1.19	-.99	3.48	.25	-5.60	14.27	1.48

to 29 petajoules in 2005 (Table 8.5). Both residential and commercial loads are expected to increase steadily. Industrial and manufacturing loads are expected to develop more quickly with the conversion of Island pulp and paper mills to natural gas from heavy fuel oil as soon as the service is available.

8.1.2.3 Liquid Hydrocarbons

In this forecast, liquid hydrocarbons are defined to include all refined petroleum products and liquefied petroleum gases. Forecast demand for these liquid hydrocarbons by product and by consuming sector is summarized in Tables 8.6 and 8.7.

Total demand for liquid hydrocarbons is projected to increase from 293 petajoules in 1984 to 429 petajoules by 2005 (Table 8.6).

The demand for liquefied petroleum gases is forecast to grow at an annual average rate of 3.0 percent. The growth is largely a result of increased use of this fuel in the road transport sector.

Residential and commercial use of refined petroleum products are forecast to grow at annual rates of 1.5 and 2.4 percent respectively over the forecast period, reaching levels of 26.3 and 27.4 PJ by 2005 (Table 8.7). Industrial use of refined petroleum products is forecast to increase from 54.4 petajoules in 1984 to 85.4 petajoules in 2005. This increase in demand is largely attributable to growth in the mining sector in the 1990's.

TABLE 8.5

FORECAST OF NATURAL GAS REQUIREMENTS
VANCOUVER ISLAND

(PETAJOULES)

YEAR	RESIDENTIAL	COMMERCIAL	LIGHT INDUSTRIAL	HEAVY INDUSTRIAL	TRANSPORT	TOTAL REQTS
1981	.000	.000	.000	.000	.000	.000
1982	.000	.000	.000	.000	.000	.000
1983	.000	.000	.000	.000	.000	.000
1984	.000	.000	.000	.000	.000	.000
1985	.000	.000	.000	.000	.000	.000
1986	.000	.000	.000	.000	.000	.000
1987	.000	.000	.000	.000	.000	.000
1988	.335	1.043	1.775	6.704	.000	9.857
1989	2.031	2.233	1.769	7.025	.089	13.147
1990	3.928	2.758	1.716	7.215	.210	15.827
1991	4.846	3.016	1.648	7.296	.341	17.167
1992	5.563	3.225	1.565	6.967	.544	17.864
1993	6.530	3.410	1.608	6.857	.606	19.011
1994	7.582	3.589	1.646	6.863	.667	20.347
1995	8.683	3.751	1.680	6.892	.730	21.736
1996	9.198	3.894	1.708	6.898	.790	22.488
1997	9.480	4.033	1.734	7.274	.851	23.372
1998	10.032	4.163	1.758	7.275	.862	24.090
1999	10.606	4.285	1.780	7.275	.873	24.819
2000	11.184	4.417	1.803	7.272	.885	25.561
2001	11.609	4.537	1.826	7.267	.897	26.136
2002	12.071	4.678	1.850	7.262	.909	26.770
2003	12.547	4.810	1.887	7.258	.921	27.423
2004	13.042	4.944	1.919	7.255	.934	28.094
2005	13.520	5.059	1.948	7.253	.946	28.726
			ANNUAL GROWTH RATES			
1984-1995	.00	.00	.00	.00	.00	.00
1995-2005	4.53	3.04	1.49	.51	2.63	2.83
1984-2005	.00	.00	.00	.00	.00	.00

TABLE 8.6

REFINED PETROLEUM PRODUCTS (RPP) END USE ENERGY REQUIREMENTS BY FUEL

(PETAJOULES)

YEAR	AVIATION GASOLINE	AVIATION TURBO	DIESEL FUEL OIL	HEAVY FUEL OIL	LIGHT FUEL OIL	L.P.G.	MOTOR[1] GASOLINE	TOTAL RESTS
1981	1.357	24.352	91.315	44.935	27.009	7.688	149.641	346.377
1982	1.009	19.530	93.109	54.707	25.526	7.824	137.283	338.988
1983	.972	18.154	81.030	35.650	19.318	7.629	130.041	293.682
1984	.939	17.974	84.498	33.826	19.953	8.104	127.573	292.867
1985	1.024	19.640	87.950	36.873	18.644	8.069	134.639	306.839
1986	1.137	21.427	92.469	37.740	18.690	8.479	141.590	321.932
1987	1.045	22.491	93.411	40.867	19.654	9.022	138.579	324.269
1988	1.055	23.712	94.787	37.694	19.823	8.734	136.342	322.147
1989	1.066	24.696	96.679	37.951	19.601	9.102	133.630	322.775
1990	1.076	25.783	99.170	38.338	18.728	9.369	131.570	324.034
1991	1.087	26.518	101.153	38.972	18.552	9.697	131.342	327.321
1992	1.098	27.336	103.583	39.091	18.243	10.020	132.990	332.361
1993	1.109	28.174	107.223	39.532	18.043	10.488	134.551	339.170
1994	1.120	29.005	110.830	39.881	17.976	10.988	136.144	345.944
1995	1.131	29.824	116.619	40.527	17.964	11.294	137.106	354.465
1996	1.142	30.514	121.892	41.126	18.564	11.725	138.138	363.101
1997	1.154	31.401	127.038	42.489	19.179	12.187	139.176	372.574
1998	1.165	32.246	130.852	42.888	19.783	12.642	139.837	379.433
1999	1.177	33.083	134.763	43.296	20.429	13.181	141.853	387.782
2000	1.189	33.831	138.403	43.695	21.125	13.745	143.693	395.681
2001	1.201	34.272	141.886	44.672	21.716	14.151	145.870	403.768
2002	1.213	34.698	145.660	45.292	22.220	14.487	147.601	411.161
2003	1.225	35.096	150.829	45.745	22.645	14.772	149.223	419.535
2004	1.237	35.481	153.584	45.906	23.021	15.024	150.745	424.998
2005	1.249	35.632	156.019	46.038	23.289	15.198	151.896	429.323
				ANNUAL GROWTH RATES				
1984-1995	1.71	4.71	2.97	1.46	-.95	3.06	.66	1.75
1995-2005	1.00	1.80	2.95	1.28	2.63	3.01	1.03	1.93
1984-2005	1.37	3.31	2.96	1.48	.74	3.04	.83	1.84

1 INCLUDES OTHER GASOLINE-LIKE RPPS USED IN PULP AND PAPER SECTOR

TABLE 8.7

REFINED PETROLEUM PRODUCTS REQUIREMENTS BY SECTOR

(PETAJOULES)

YEAR	RESIDENTIAL	COMMERCIAL	PULP AND PAPER	WOOD PRODUCTS	CHEMICALS	OTHER MAN.	MINING	ROAD	RAIL	MARINE	AIR	TOTAL REQTS
1981	26.441	19.181	26.742	3.387	.671	19.173	11.036	178.759	10.856	44.423	25.709	366.378
1982	21.548	17.439	25.188	2.521	.659	16.901	10.267	175.077	10.288	36.543	20.539	338.990
1983	21.771	15.334	22.997	3.125	.497	12.890	10.241	158.605	10.535	18.490	19.126	293.601
1984	19.172	16.704	22.511	4.550	.987	14.074	12.731	156.893	13.612	13.200	18.913	292.867
1985	17.201	17.115	25.630	5.782	.494	16.592	14.696	167.589	13.612	12.464	20.664	306.839
1986	16.876	18.415	23.525	6.222	.518	17.536	14.698	170.916	14.171	16.292	22.764	321.933
1987	18.112	18.467	22.882	6.279	.539	18.538	14.866	167.190	15.035	18.818	23.536	324.272
1988	19.828	16.939	18.311	5.338	.706	18.423	14.908	165.293	16.009	22.126	24.767	322.148
1989	20.344	15.969	18.792	5.096	.214	18.754	15.087	163.505	16.744	22.459	25.762	322.726
1990	19.995	15.492	19.343	4.632	.220	18.917	15.985	163.016	17.302	22.773	26.859	324.034
1991	20.029	15.674	19.833	4.083	.226	19.486	15.971	163.479	17.824	23.114	27.605	327.323
1992	19.705	16.202	19.682	3.475	.239	20.078	16.491	166.183	18.358	23.440	28.434	332.357
1993	19.684	17.076	19.786	3.534	.255	20.702	16.997	168.916	18.865	24.099	29.283	339.119
1994	19.696	17.715	19.812	3.570	.272	21.355	17.528	171.723	19.391	24.758	30.125	345.945
1995	19.855	18.440	19.888	3.581	.289	21.757	20.581	173.698	19.967	25.543	30.955	354.464
1996	20.518	19.647	19.909	3.570	.302	22.250	22.772	175.663	20.391	26.423	31.656	363.101
1997	21.134	20.999	20.710	3.539	.315	22.818	24.806	177.575	20.711	27.417	32.555	372.573
1998	21.732	22.467	20.711	3.498	.327	23.342	25.270	179.203	20.961	28.589	33.411	379.431
1999	22.388	24.022	20.703	3.455	.341	23.898	25.743	182.129	21.166	29.683	34.260	387.790
2000	23.123	25.564	20.695	3.410	.354	24.463	26.217	184.871	21.342	30.634	35.020	395.683
2001	23.897	26.275	20.684	3.372	.367	24.994	27.748	187.940	21.499	31.538	35.473	403.767
2002	24.637	26.702	20.646	3.347	.382	25.459	29.529	190.547	21.646	32.363	35.901	411.159
2003	25.266	27.036	20.631	3.405	.397	25.936	32.652	193.075	21.789	33.090	36.321	419.537
2004	25.824	27.321	20.620	3.446	.413	26.518	33.178	195.380	21.926	33.456	36.718	425.000
2005	26.285	27.358	20.629	3.467	.428	27.173	33.707	197.339	22.064	34.041	36.881	429.372
						ANNUAL GROWTH RATES						
1984-1995	.32	.90	-1.13	-2.15	-4.63	4.04	4.43	.93	3.54	6.19	4.58	1.75
1995-2005	2.85	4.02	.37	-.32	4.01	2.23	5.10	1.28	1.00	2.91	1.77	1.93
1984-2005	1.51	2.38	-.42	-1.29	-.61	3.17	4.75	1.10	2.33	4.61	3.23	1.84

'OTHER MAN.' INCLUDES PRIMARY METALS, REFINERIES, NON-METALLIC MINERALS, AND OTHER INDUSTRIES N.E.S

The transport sector accounted for 69 percent of the total liquid hydrocarbon demand in British Columbia in 1984. Reductions in road use of motor gasoline are forecast after 1986/87 into the early 1990's because of greater use of smaller and more fuel efficient passenger vehicles and despite an expanding automobile fleet. Use of heavy fuel oil as marine bunker is expected to grow as a result of tax concessions. Total demand for refined petroleum products in the transportation sector in the year 2005 will be 47 percent above 1984 levels.

8.1.2.4 Other Energy Sources

The demand for other energy is forecast to increase by 79 petajoules from 180 PJ in 1984 to 259 PJ in 2005 (Table 8.8). Some coal and 8 petajoules of renewable energy will be used in the residential sector in 2005. The balance, hog fuel, waste liquor, coal and coke, and other by-product energy are used in the industrial sector.

8.2 Requirements for Energy Supply Industries

Requirements in the energy supplying industries account for energy expended in the provision of secondary energy. This includes refinery own-use in the production of RPPs, pipeline fuel and losses in the transmission of natural gas and losses in transmission and utility own-use of electricity.

Requirements in this section are reported by supply industry: electric power, natural gas and refineries (see Table 8.9).

Table 8.8

End-Use Energy Requirements for Other Energy Sources

(Petajoules)

Year	Coal and Coke	Hog Fuel	Pulping Liquors	Renewable Energy	Other	Total Requirements
1984	2.7	71.5	106.1	--	--	180.3
1985	4.0	79.5	120.5	--	--	204.0
1990	16.4	87.7	123.3	1.4	1.0	229.7
1995	19.6	90.3	127.8	3.1	1.0	241.9
2000	22.2	91.4	130.0	5.3	1.0	249.9
2005	22.7	93.7	133.6	7.7	1.0	258.7
AAR %						
1984-2005	10.7	1.3	1.1	--	--	1.7

TABLE 8.9

LOSSES AND FUEL USED BY ENERGY SUPPLY INDUSTRIES

(PETAJOULES)

YEAR	NATURAL GAS			ELECTRICITY		OIL			
	LOSSES	BURRARD	SUB-TOTAL	LOSSES	TRANSF TO ELEC[1]	OWN-USE	LPG	SUB-TOTAL	TOTAL
1981	14.456	.334	14.790	15.613	-.114	17.071	.756	17.827	48.116
1982	13.635	.380	14.015	14.076	-.129	14.474	.054	14.528	42.490
1983	13.547	.038	13.585	14.817	-.013	14.171	.571	14.742	43.131
1984	13.939	.656	14.595	16.798	-.223	15.828	.052	15.880	47.050
1985	14.408	2.000	16.408	17.019	-.680	9.311	.052	9.363	42.110
1986	14.154	2.000	16.154	17.655	-.680	9.952	.052	10.004	43.133
1987	14.738	2.000	16.738	17.786	-.680	9.920	.052	9.972	43.816
1988	16.191	2.000	18.191	17.980	-.680	9.476	.052	9.728	45.219
1989	17.383	2.000	19.383	18.190	-.680	9.199	.052	9.251	46.144
1990	18.257	2.000	20.257	18.614	-.680	9.155	.052	9.207	47.398
1991	19.059	5.000	24.059	18.928	-1.700	9.183	.052	9.235	50.522
1992	19.700	5.000	24.700	19.464	-1.700	9.237	.052	9.289	51.753
1993	20.293	5.000	25.293	19.897	-1.700	9.364	.052	9.416	52.906
1994	20.788	5.000	25.788	20.328	-1.700	8.606	.052	8.658	53.074
1995	21.107	5.000	26.107	20.640	-1.700	5.730	.052	5.782	50.829
1996	21.351	5.000	26.351	21.127	-1.700	6.076	.052	6.128	51.906
1997	21.770	5.000	26.770	21.715	-1.700	6.166	.052	6.218	53.003
1998	22.195	5.000	27.195	22.335	-1.700	6.239	.052	6.291	54.121
1999	22.535	5.000	27.535	22.987	-1.700	6.307	.052	6.359	55.201
2000	22.861	5.000	27.861	23.645	-1.700	6.375	.052	6.427	56.233
2001	22.890	5.000	27.890	23.989	-1.700	6.424	.052	6.476	56.655
2002	23.050	5.000	28.050	24.388	-1.700	6.443	.052	6.495	57.233
2003	23.286	5.000	28.286	24.788	-1.700	6.442	.052	6.494	57.868
2004	23.613	5.000	28.613	25.184	-1.700	6.448	.052	6.500	58.597
2005	23.958	5.000	28.958	25.532	-1.700	6.442	.052	6.494	59.284
				ANNUAL GROWTH RATES					
1984-1995	3.84	20.28	5.43	1.89	20.28	-8.82	.00	-8.78	.70
1995-2005	1.26	.00	1.04	2.15	.00	1.18	.00	1.17	1.55
1984-2005	2.61	10.15	3.32	2.01	10.15	-4.19	.00	-4.17	1.11

1 ELECTRICITY GENERATED BY BURNING NATURAL GAS AT BURRARD

8.2.1 Electricity

Consumption of electricity by the electricity supply industry includes estimates of B.C. Hydro's own-use, losses on the Cominco system and losses for five different end-use voltages on the B.C. Hydro and West Kootenay Power and Light systems.

B.C. Hydro's own-use was determined as a fixed percentage of sales in each year. Losses on the Cominco system were set at 1.5 percent of electricity generated in the operation of its ammonia-urea plant and lead/zinc smelter.

Losses were estimated for bulk, over 35 KW-primary, over 35 KW-secondary, under 35 KW-secondary and residential-secondary categories. Ratios of losses to sales in each of these categories were applied to requirements in the appropriate categories to obtain total losses.

Estimates of total electricity for the supply industries shown in Table 8.9 also include electricity used by oil and gas pipelines.

8.2.2 Natural Gas

Pipeline fuel and losses refer to natural gas consumed downstream of gas plants in compressors and heaters and those volumes unaccounted for or lost through meter inaccuracies. The estimates of pipeline fuel and losses presented here were prepared using the analysis developed for the Govier Inquiry on B.C.'s Requirements, Supply and Surplus of Natural Gas and Natural Gas Liquids. Reported as well are natural gas requirements used by utilities for the purpose of generating electricity.

Natural gas distribution losses were calculated for each distribution utility based on end-use requirements. These volumes were used to proportion total provincial requirements by service area after which ratios of losses to requirements were applied for each service area. Requirements in B.C. Hydro's service area were, however, separated into firm and interruptible categories before these ratios were applied.

Provision has also been made for natural gas in the generation of electricity by utilities. B.C. Hydro operates several natural gas fired facilities in the province including Burrard, Fort Nelson and Prince Rupert. The facility at Prince Rupert is an interruptible stand-by facility which uses a small quantity of natural gas. The Fort Nelson facility provides electricity for the Fort Nelson area and is not connected to the B.C. Hydro integrated grid.

B.C. Hydro reported to the Govier Inquiry that the Burrard generating plant is intended for meeting shortfalls in electricity supply due to transmission outages, to compensate for low water conditions which reduce the ability of the hydroelectric generating facilities to provide service, and to provide supply in the event of delays in start-up dates of new generating projects.[2]

For the purpose of this forecast, the Ministry assumed approximately 2 petajoules of natural gas will be consumed

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2 For planning purposes, B.C. Hydro assumes that Burrard could provide 3170 GWh annually - that is 11 PJ of electricity. This is viewed as a contingency rather than a continuous source of electricity supply.

annually at Burrard to meet emergency transmission outages. After 1990, an additional allowance averaging 3 petajoules per year is made for meeting potential generation shortfalls resulting from low water levels.

8.2.3 Refined Petroleum Products

Own use of RPP's is defined to include refinery use of RPP's and gas plant use of liquefied petroleum gases (LPG). Gas plant use of LPG's has been held constant at the 1984 value of 0.05 PJ.

8.3 Primary Energy Requirements

Primary energy requirements were derived by adding total end-use energy requirements, distribution and transmission losses associated with the supply of natural gas and electricity, and the fuel consumed by oil refineries. In addition, energy consumed in the form of thermal electricity was converted into primary fuel by using a conversion factor of 10.55 MJ per kwh and this was added into the primary energy totals shown in Table 8.10. The electricity estimates were correspondingly reduced to reflect this quantity of thermal electricity.

Primary energy requirements in the province are expected to increase from 831 petajoules in 1984 to 1211 petajoules in 2005 indicating an annual average growth rate of 1.8 percent.

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TABLE 8.10

PRIMARY ENERGY REQUIREMENTS FORECAST
BRITISH COLUMBIA

(PETAJOULES)

YEAR	NATURAL GAS	ELECT.	TOTAL RPP	OTHER	TOTAL RENTS
1981	171.976	153.565	384.204	164.810	874.555
1982	178.559	153.434	353.516	163.953	849.462
1983	180.419	154.895	308.344	180.005	823.663
1984	181.576	160.089	308.747	180.307	830.719
1985	188.096	170.754	316.202	204.021	879.073
1986	181.479	176.429	331.936	215.172	905.016
1987	186.003	177.697	334.241	222.345	920.286
1988	201.427	179.135	331.875	225.195	937.632
1989	212.660	180.770	331.976	228.021	953.427
1990	221.534	184.836	333.241	229.684	969.295
1991	232.332	185.717	336.556	235.219	989.824
1992	238.756	190.627	341.650	233.544	1004.577
1993	244.406	193.972	348.536	236.974	1023.888
1994	248.292	197.185	354.602	238.783	1038.862
1995	248.687	198.677	360.247	241.896	1049.507
1996	250.625	202.229	369.229	246.772	1068.855
1997	254.344	207.975	378.792	246.880	1087.991
1998	257.938	212.960	385.724	247.907	1104.529
1999	260.704	228.355	394.141	248.902	1132.102
2000	262.799	233.383	402.108	249.870	1148.160
2001	260.357	238.600	410.244	252.800	1162.001
2002	260.303	241.874	417.656	253.614	1173.447
2003	261.255	244.559	426.029	254.489	1186.332
2004	263.433	247.445	431.498	255.729	1198.105
2005	266.061	250.112	435.817	258.702	1210.692
			ANNUAL GROWTH RATES		
1984-1995	2.90	1.98	1.41	2.71	2.15
1995-2005	.68	2.33	1.92	.67	1.44
1984-2005	1.84	2.15	1.65	1.73	1.81

8.4 Primary Fuel Requirements

Total demand for primary fuels in British Columbia is forecast to increase from 866 petajoules in 1984 to 1273 petajoules in 2005 reflecting an annual average growth rate of 1.8 percent (Table 8.11).

These estimates are derived from the primary energy requirements forecast by adding requirements for natural gas as a feedstock and the non-energy related consumption of refined petroleum products.

The demand for natural gas is expected to experience growth of about 1.8 percent per annum over the 1984-2005 period. Over the first half of the forecast period the growth rate is expected to be higher, approximately 2.9 percent per annum. This higher growth in natural gas demand is the result of extension of natural gas service to Vancouver Island starting in 1988.

The demand for natural gas is forecast to increase from 199 petajoules in 1984 to 289 petajoules in 2005. Primary fuel demand for petroleum products is forecast to increase from 327 petajoules in 1984 to 475 petajoules in 2005 indicating an annual average growth rate of 1.8 percent. Primary electricity requirements are anticipated to increase from 160 PJ to 250 PJ in 2005.

TABLE 8.11

PRIMARY FUEL REQUIREMENTS

(PETAJOULES)

YEAR	NATURAL GAS			ELECTRICITY	TOTAL RPP			OTHER	TOTAL
	ENERGY	NON ENERGY	TOTAL		ENERGY	NON ENERGY	TOTAL		
1981	171.976	2.418	174.394	153.565	384.204	28.978	413.182	164.810	905.951
1982	178.559	8.101	186.660	153.434	353.516	18.004	371.520	163.953	875.567
1983	180.419	15.062	195.481	154.895	308.344	20.132	328.476	180.005	858.857
1984	181.576	17.397	198.973	160.089	308.747	17.921	326.668	180.307	866.037
1985	188.096	18.092	206.188	170.754	316.202	20.456	336.658	204.021	917.621
1986	181.479	18.570	200.049	176.429	331.936	22.899	354.835	215.172	946.485
1987	186.003	22.733	208.736	177.697	334.241	25.151	359.392	222.345	968.170
1988	201.427	22.758	224.185	179.135	331.875	25.761	357.636	225.195	986.151
1989	212.660	22.783	235.443	180.770	331.976	26.340	358.316	228.021	1002.550
1990	221.534	22.808	244.342	184.836	333.241	26.919	360.160	229.684	1019.022
1991	232.332	22.834	255.166	185.717	336.556	27.484	364.040	235.219	1040.142
1992	238.756	22.859	261.615	190.627	341.650	28.056	369.706	233.544	1055.492
1993	244.406	22.885	267.291	193.972	348.536	28.675	377.161	236.974	1075.398
1994	248.292	22.912	271.204	197.185	354.602	29.194	383.796	238.783	1090.968
1995	248.687	22.938	271.625	198.677	360.247	29.762	390.009	241.896	1102.207
1996	250.625	22.965	273.590	202.229	369.229	30.310	399.539	246.772	1122.130
1997	254.344	22.992	277.336	207.975	378.792	30.865	409.657	246.880	1141.848
1998	257.938	23.020	280.958	212.960	385.724	31.417	417.141	247.907	1158.966
1999	260.704	23.047	283.751	228.355	394.141	35.833	429.974	248.902	1190.982
2000	262.799	23.075	285.874	233.383	402.108	36.387	438.495	249.870	1207.622
2001	260.357	23.104	283.461	238.600	410.244	36.943	447.187	252.800	1222.048
2002	260.303	23.132	283.435	241.874	417.656	37.505	455.161	253.614	1231.084
2003	261.255	23.161	284.416	244.559	426.029	38.080	464.109	254.489	1247.573
2004	263.433	23.190	286.623	247.445	431.498	38.666	470.164	255.729	1259.961
2005	266.061	23.219	289.280	250.112	435.817	39.212	475.029	258.702	1273.123
				ANNUAL GROWTH RATES					
1984-1995	2.90	2.55	2.87	1.98	1.41	4.72	1.62	2.71	2.22
1995-2005	.68	.12	.63	2.33	1.92	2.80	1.99	.67	1.45
1984-2005	1.84	1.38	1.80	2.15	1.65	3.80	1.80	1.73	1.85

CHAPTER 9

CONVENTIONAL ENERGY SUPPLIES

9.0 Introduction

This chapter considers the outlook for domestic conventional energy sources capable of meeting the province's energy requirements. The supply forecasts for different fuels incorporate different methodologies and assumptions.

Existing hydroelectric projects, repatriated Columbia River power and a portion of potential supply from other sources (e.g., purchases) have been included in the estimate of B.C. Hydro's electricity supply. The resulting demand/supply balance suggests that B.C. Hydro will have to acquire additional energy supply in 1997. Electricity supply is summarized in section 9.1.

The future supply of natural gas depends on the rate of exploration and development activity in the petroleum industry. Assumptions regarding the level of those activities are combined with the forecast of demand for natural gas by domestic and committed export customers to derive the supply forecast for marketable natural gas. Section 9.2 presents the outlook for natural gas.

British Columbia meets only about 25 percent of its requirements for crude oil from domestic sources, and is likely to require continued transfers of crude oil or petroleum products into the province in the foreseeable future. It is therefore assumed that the production of domestic oil is constrained only by the producibility of the resource. Domestic oil producibility and heavy fuel oil production from domestic petroleum refineries is reviewed in sections 9.3 and 9.4.

The production of hog fuel has been discussed in Chapter 5, and is summarized in section 9.5.

9.1 Electricity

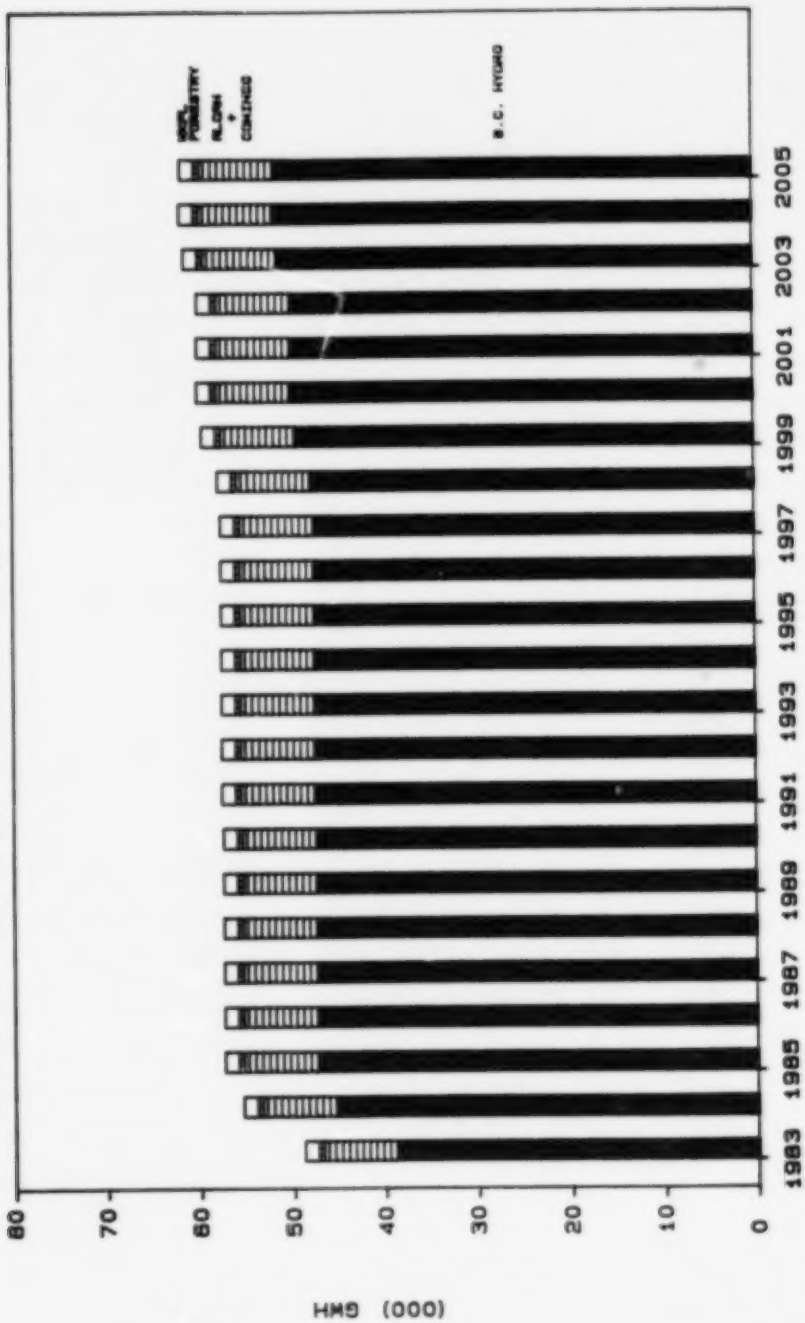
9.1.1 Existing Supply

Total provincial electricity supply has been defined to include all hydroelectric and utility-owned thermal generation facilities. Total provincial electricity supply is reported in Figure 9.1 where the present capabilities of B.C. Hydro, West Kootenay Power and Light (WKPL), Alcan, Cominco and the forest industry have been identified separately.

B.C. Hydro is by far the largest supplier of electricity in the province. Electricity supply for B.C. Hydro is defined to be "firm" where firm refers to hydroelectricity generated under "critical water conditions". Critical water conditions are defined as the lowest stream flow sequence for the B.C. Hydro system as a whole during the forty year period from 1940 to 1980.

Included in the definition of B.C. Hydro's firm capability is the potential generation from the Burrard thermal plant. During low stream flow periods, the Burrard Thermal Plant would be operated on "Valley Gas" which is surplus natural gas available from B.C. Hydro's gas operations when daily natural gas requirements are less than contract levels during the March to October period. Burrard could contribute an average of 3170 GWh annually corresponding to a 40 percent annual capacity factor for the 900 MW plant.

FIGURE 9.1
PROVINCIAL ELECTRICITY CAPABILITY



Firm energy capability for B.C. Hydro also includes 2,200 GWh annually for "purchases and other" from sources such as TransAlta Utilities Corp. However, potential supplies to B.C. Hydro from these sources could be much larger. For exposition purposes these have been fixed at 2200 GWh annually. Further discussion about potential sources of electricity to B.C. Hydro is contained in Chapter 10.

In 1985, B.C. Hydro's firm capability amounted to 47,320 GWh annually (170.35 PJ). This level is assumed to remain fixed until 1991 when generation from the Seven Mile Dam would be increased by 150 GWh as part of the Skagit Treaty with the United States whereby British Columbia exports 318 GWh annually to the City of Seattle beginning in 1986. Further, it is assumed that return of the Columbia River Treaty Downstream Benefits in 1998 will increase the firm energy available to B.C. Hydro. By 2005, B.C. Hydro firm energy capability will amount to 51,648 GWh (186 PJ).

Figure 9.1 also reports the energy available from Cominco, Alcan and WKPL. Cominco operates the Brilliant and Waneta dams with a combined installed capacity of 469 MW. WKPL operates the Lower and Upper Bonnington, the South Slocan and the Corra Linn dams with a combined installed capacity of 185 MW. Under the Canal Plant Agreement of 1972, B.C. Hydro is obligated to supply Cominco with 3319 GWh annually and WKPL with 1525 GWh. For the purpose of this forecast the Agreement's terms have been assumed to remain in effect until 2005.

Alcan operates the Kemano power house on the Nechako Reservoir with an installed capacity of 813 MW. Capability is 6410 GWh or 23 PJ annually.

In Figure 9.1, Alcan's capability has been fixed at this level. The forest sector is assumed to contribute 525 GWh or 1.9 PJ annually to total provincial hydro supply over the forecast period.

9.1.2 Future Supply

While a number of potential hydro and thermal projects could be brought on stream to meet a growing demand for electricity, none of these have been included in the supply estimates of Figure 9.1 since all projects over 20 MW are subject to government review and approval. However future supply options include those listed in Table 9.1. The Kemano completion project is also a source of future hydroelectric supply.

Table 9.1

Potential Hydroelectric Supply Options
(GWh/Year)

	Critical (Firm)	Average
Keenleyside	830	870
Murphy Creek	1,700	1,970
Peace Site-C	4,740	4,770

9.2 Marketable Natural Gas

The supply of natural gas depends upon the rate at which gas is produced from established marketable gas reserves and reserves additions. As of December 31, 1984, British Columbia had approximately 236 billion cubic metres (9180 PJ) of remaining established marketable natural gas

reserves. Presently 64 percent of these reserves are connected to gas processing facilities and the remaining 36 percent are expected to be connected by 1997. In addition, the province has a potential of about 475 billion cubic metres (18,478 PJ) of marketable gas reserves that remain to be discovered.

A set of specific assumptions has been employed in developing producibility from connected and unconnected reserves. With respect to new discoveries, however, the rate at which new reserves are added is first estimated and then the producibility profile for these reserves additions is developed.

Determination of the rate at which reserves are added is based on drilling and exploration activity. The drilling activity forecast which forms the basis of this gas supply forecast is detailed in Table 9.2. Based on this scenario, another 153 billion cubic metres (5952 PJ) of marketable gas reserves will be added by 2005.

Connected gas reserves currently supply 12.1 billion cubic metres (471 PJ) of marketable gas annually (see Table 9.2), but this is forecast to decline to 2.3 billion cubic metres (88 PJ) in 2005. Supply from presently unconnected reserves is forecast to start in 1987 and increase gradually to a peak value of 4.7 billion cubic metres (180 PJ) in 1996.

The supply from reserves additions will to become available after an initial lag of 4 years. Starting from a level of 0.05 billion cubic metres (1.9 PJ) in 1989, the producibility from reserves addition is projected to increase to 5.5 billion cubic metres (211 PJ) in 2005. The total supply of marketable gas from indigenous sources is

Table 9.2

Maximum Annual Producibility of Marketable Natural Gas

(billions of cubic metres)

Year	Drilling Forecast (Wells)*	Connected	Unconnected	Additions Due to Drilling	Total
1985	50	12.143	0	0	12.143
1986	50	11.657	0	0	11.657
1987	50	11.191	0.367	0	11.558
1988	75	10.520	1.101	0	11.620
1989	100	9.888	2.596	0.054	12.539
1990	100	9.295	3.725	0.181	13.200
1991	100	8.737	3.725	0.342	12.804
1992	100	8.213	3.725	0.564	12.502
1993	100	7.720	4.459	0.872	13.051
1994	100	7.257	4.459	1.220	12.936
1995	150	6.531	4.459	1.563	12.553
1996	150	5.878	4.656	1.900	12.435
1997	150	5.290	4.619	2.233	12.143
1998	150	4.761	4.513	2.562	11.836
1999	150	4.285	4.268	2.959	11.512
2000	200	3.857	3.934	3.417	11.208
2001	200	3.471	3.634	3.850	10.955
2002	200	3.124	3.363	4.254	10.741
2003	200	2.812	3.047	4.623	10.481
2004	200	2.530	2.762	5.026	10.318
2005	200	2.277	2.506	5.463	10.246

* Number of exploratory natural gas wells.

projected to increase from 12.1 billion cubic metres (471 PJ) to a peak value of 13.2 billion cubic metres (507 PJ) in 1990 declining subsequently to 10.2 billion cubic metres (392) PJ in 2005.

Aside from indigenous supply sources, British Columbia has some extra-provincial supplies available to it by virtue of certain contractual arrangements. These extra-provincial supplies include, for example, Amoco gas, Pan Alberta gas, and Westcoast's traditional gas supplies in Alberta. Consequently, the potential supply of gas available to the province is slightly higher than shown in Table 9.2.

9.3 Crude Oil From Domestic Producers

The forecast of domestic crude oil supply is developed by the Petroleum Resources Division of the Ministry. The forecast represents aggregate producibility from established reserves and anticipated new discoveries. In developing this forecast it was assumed that additional supplies that could be available through tertiary recovery operations would not be economic.

Remaining established crude oil reserves in the province, as of December 31, 1984, are estimated around 18.8 million cubic metres (724 PJ). Forecasts of producibility from these established reserves are developed on a pool-by-pool basis and aggregated to determine total producibility. Producibility from established reserves is forecast to decline by 55 percent from 2.0 million cubic metres (77 PJ) per year in 1985 to 0.9 million cubic metres (35 PJ) in 1995. Over the second half of the forecast period this decline is expected to moderate slightly. By the end of the forecast period, producibility from the established reserves

is projected to be 0.45 million cubic metres (17 PJ) (Table 9.3).

The Ministry has assumed that aside from the major discovery of the Desan oil field in 1984, one other major oil discovery will occur in 1992 providing 1.5 million cubic metres (58 PJ) of oil reserves. Production from this new discovery is forecast to reach a level of 0.15 million cubic metres (6.0 PJ) in 1996 and to stay at this level until 1999 before tapering off to 0.08 million cubic metres (3.1 PJ) in 2005.

The Ministry holds the view that the projected oil price does not support the development of the Desan oil field, until 1995. By the end of the forecast period, production from Desan is expected to be 0.2 million cubic metres (7.7 PJ).

The total supply of crude oil from indigenous sources is forecast to decline from 2.0 million cubic metres (77 PJ) in 1985 to 1.01 million cubic metres (39 PJ) in 1995. Further declines are expected, at a slower pace, to 0.7 million cubic metres (27 PJ) in 2005.

9.4 Heavy Fuel Oil

The production of heavy fuel oil has been forecast as a function of refinery capacity, refinery throughput and the quality of the crude oil feedstock. Table 9.4 presents a summary of domestic heavy fuel oil production.

This forecast incorporates the assumption that expansion of refinery capacity in British Columbia will not occur. Additionally, the forecast has allowed for the possibility

Table 9.3

Annual Domestic Crude Oil Producibility

(thousands of cubic metres)

Year	Established	New Discoveries	Desan	Total
1985	1958.2	--	--	1958.2
1986	1950.0	--	--	1950.0
1987	1835.5	--	--	1835.5
1988	1667.6	--	--	1667.6
1989	1515.1	--	--	1515.1
1990	1379.7	--	--	1379.7
1991	1261.5	--	--	1261.5
1992	1153.7	--	--	1153.7
1993	1058.3	--	--	1058.3
1994	973.7	73.0	--	1046.7
1995	896.4	109.5	3.7	1009.5
1996	828.0	146.0	21.9	995.9
1997	764.2	146.0	54.8	964.9
1998	705.2	146.0	105.1	956.4
1999	659.9	146.0	125.2	931.0
2000	622.9	131.4	143.1	897.4
2001	590.4	118.3	143.1	851.7
2002	546.9	106.7	157.3	810.8
2003	508.7	95.6	170.1	774.4
2004	475.5	86.1	165.7	727.3
2005	445.2	77.4	176.7	699.2

Table 9.4

Production of Heavy Fuel Oil
by Domestic Refineries

Year	B.C. RPP Production (PJ)	Average HFO Yield (percent)	Production of HFO (PJ)
1984	317.3	8.5	27.0
1985	304.3	7.7	23.6
1986	321.0	7.7	24.9
1987	321.5	7.7	24.9
1988	321.8	7.7	24.9
1989	314.8	7.7	24.4
1990	315.7	7.7	24.4
1991	316.0	7.7	24.5
1992	315.8	7.7	24.4
1993	315.7	7.7	24.4
1994	290.5	7.7	22.5
1995	199.8	7.7	15.5
1996	209.5	7.7	16.2
1997	210.0	7.7	16.3
1998	210.1	7.7	16.3
1999	209.9	7.7	16.3
2000	209.9	7.7	16.3
2001	209.9	7.7	16.3
2002	209.9	7.7	16.3
2003	209.7	7.7	16.2
2004	210.0	7.7	16.3
2005	210.0	7.7	16.3

of closure of more than one refinery in British Columbia.

As shown in Table 9.4, the total production of refined petroleum products in British Columbia is forecast to decline from 317 PJ in 1984 to 210 PJ in 2005. Most of the refining companies that operate in British Columbia have larger and newer refinery facilities in Alberta. Hence, refiners in the province would be inclined to supply British Columbia with products from their Alberta refining facilities at lower cost.

The average yield of heavy fuel oil is forecast on the basis of anticipated changes in upgrading facilities and the quality of available crude oil. Both the consumption of synthetic crude at the Shell refinery and the investments in the Chevron refinery have reduced the average heavy fuel oil yield significantly. The heavy fuel oil yield as a proportion of throughput on an energy basis has already fallen from 11.3 percent in 1981 to 8.5 percent in 1984. In this forecast a further decline to 7.7 percent is assumed for 1985. After 1985, it is assumed that this yield will remain at the 1985 level.

The total production of heavy fuel oil from domestic petroleum refineries is forecast to decline from 27.0 PJ in 1984 to 16.3 PJ in 2005.

9.5 Hog Fuel

Hog fuel consists of bark, sawdust and shavings which are generated in the manufacture of wood products. The methodology for determining the supply of hog fuel has been outlined briefly in Chapter 5. Supply is a function of the forecast lumber production levels, the volume of bark

associated with timber production and the efficiency with which wood producers are able to convert timber into final products.

The supply of hog fuel is forecast to increase from 158 PJ in 1984 to 176 PJ in 2005 (see Table 9.5). This growth occurs as the lumber market recovers. The increase is moderated somewhat by the increased consumption of sawdust and shavings as pulp furnish in the production of kraft pulp.

Table 9.5

Hog Fuel Supply

(Petajoules)

Year	S. Coast	N. Coast	Interior	Total
1984	51.3	11.7	95.3	158.3
1985	53.2	12.1	103.9	169.2
1986	52.0	11.8	106.3	170.1
1987	50.4	12.4	107.7	170.5
1988	49.4	12.3	106.8	168.5
1989	48.9	12.8	106.0	167.7
1990	49.6	12.4	105.2	167.2
1991	50.2	11.8	104.0	166.0
1992	50.4	11.5	103.9	165.8
1993	50.5	11.7	103.4	165.6
1994	50.5	11.8	103.2	165.5
1995	50.5	12.0	103.1	165.6
1996	51.4	11.9	103.0	166.3
1997	51.9	12.1	102.9	166.9
1998	52.5	12.2	102.9	167.6
1999	53.0	12.4	102.8	168.2
2000	53.6	12.6	102.7	168.9
2001	53.9	13.0	102.7	169.6
2002	53.9	13.7	102.5	170.1
2003	53.9	14.5	102.5	170.9
2004	54.0	15.2	102.4	171.6
2005	57.6	16.0	102.0	175.6

CHAPTER 10

SUPPLY/REQUIREMENTS BALANCE

10.0 Introduction

This chapter provides an overview of the supply/requirement balances for the major energy types in British Columbia including electricity, natural gas, liquid hydrocarbons (refined petroleum products), heavy fuel oil and hog fuel. Requirements have been defined to include transmission and distribution losses and producer own-use, where applicable.

In summary, it is anticipated that new electricity generation facilities will not be required on the B.C. Hydro system until early 1997 and that sufficient surplus natural gas exists for the province to meet its existing commitments. The province will continue as a net importer of liquid hydrocarbons, including heavy fuel oil. Sufficient hog fuel supplies exist to meet requirements.

10.1 Electricity

This section combines the total provincial supply of electricity as reported in Chapter 9 with total provincial electricity requirements as reported in Chapter 8. Because B.C. Hydro supplies most of the electricity in the province and will develop the remaining grid-connected major hydroelectric sites apart from Kemano completion, a more in-depth focus of the supply/demand balance on the B.C. Hydro system is also undertaken.

Provincial requirements have been defined to include sales of purchased electricity, export sales under the Skagit

Agreement to the City of Seattle, industrial requirements met from self-generated sources, losses in transmission and distribution and own-use by utilities. Provincial electricity supply on the other hand, has been defined to include all existing hydroelectric projects under criticial water conditions on the B.C. Hydro system as well as firm supply capability from Alcan, Cominco, WKPL and industrial sources.

Major new projects requiring Energy Project Certificates, such as Peace River Site-C, have been excluded from the definition of supply so that the timing and magnitude of new electricity projects can be identified.

The supply/demand balance for electricity at the provincial level indicates that additional electricity supplies will be required by 1999 (see Figure and Table 10.1). Total provincial electricity requirements are projected to grow at an average annual rate of 2.1 percent between 1984 and 2005.

The B.C. Hydro system is projected to grow at an average annual rate of 2.3 percent between 1984 and 2005 (see Figure and Table 10.2). Additional electricity supplies will be required by 1997. However, recent analysis by B.C. Hydro, indicates that the 2200 GWh identified as "other" sources (see Chapter 9) of supply may be too conservative in detailing the supply options available to B.C. Hydro. With varying degrees of certainty, additional "non-firm" electricity could be available to B.C. Hydro from other sources such as secondary hydroelectricity, purchases from Alberta, the United States and Alcan, cogeneration, Burrard on firm gas, and conservation. However, for expositional purposes "other" sources have been held fixed at 2200 GWh.

FIGURE 10.1
TOTAL PROVINCIAL ELECTRICITY
SUPPLY DEMAND BALANCE

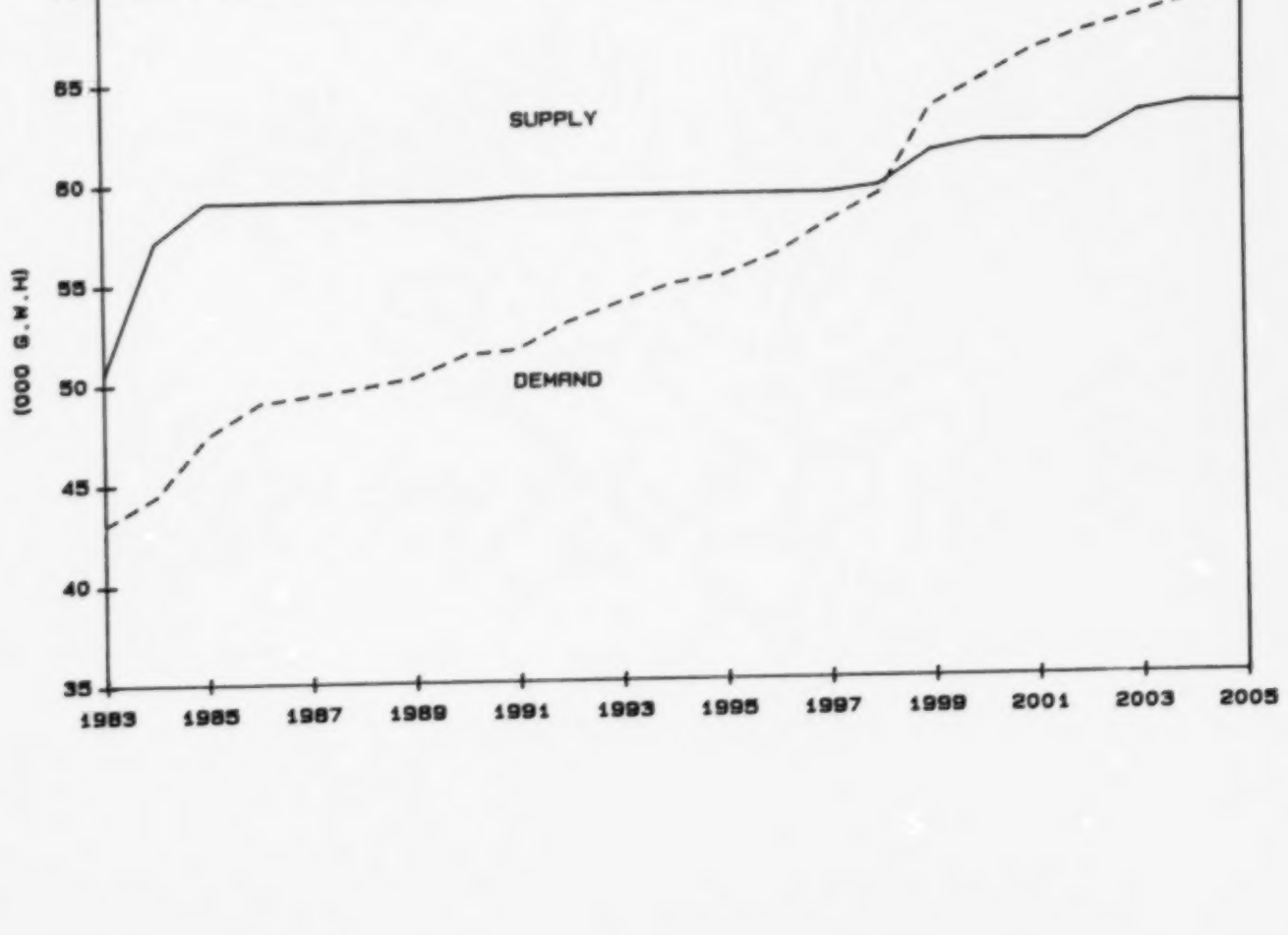


Table 10.1

Provincial Electricity Supply/Demand Balance
(GWh)

Year	Total Provincial Requirements	Total Firm Provincial Supply	Supply/Demand Balance (deficit)
1984(act.)	44,469	57,134	12,665
1985(est.)	47,432	59,099	11,667
1986	49,008	59,099	10,091
1987	49,360	59,099	9,739
1988	49,760	59,099	9,339
1989	50,214	59,099	8,885
1990	51,343	59,099	7,756
1991	51,588	59,249	7,661
1992	52,952	59,249	6,297
1993	53,881	59,249	5,368
1994	54,774	59,249	4,475
1995	55,188	59,249	4,061
1996	56,175	59,249	3,074
1997	57,771	59,249	1,478
1998	59,156	59,564	408
1999	63,432	61,247	(2,185)
2000	64,829	61,740	(3,089)
2001	66,278	61,700	(4,578)
2002	67,187	61,660	(5,527)
2003	67,933	63,080	(4,853)
2004	68,735	63,500	(5,235)
2005	69,476	63,425	(6,051)
AAR			
1984-2005	2.1	0.5	--

FIGURE 10.2
B.C.HYDRO SYSTEM ELECTRICITY SUPPLY DEMAND BALANCE

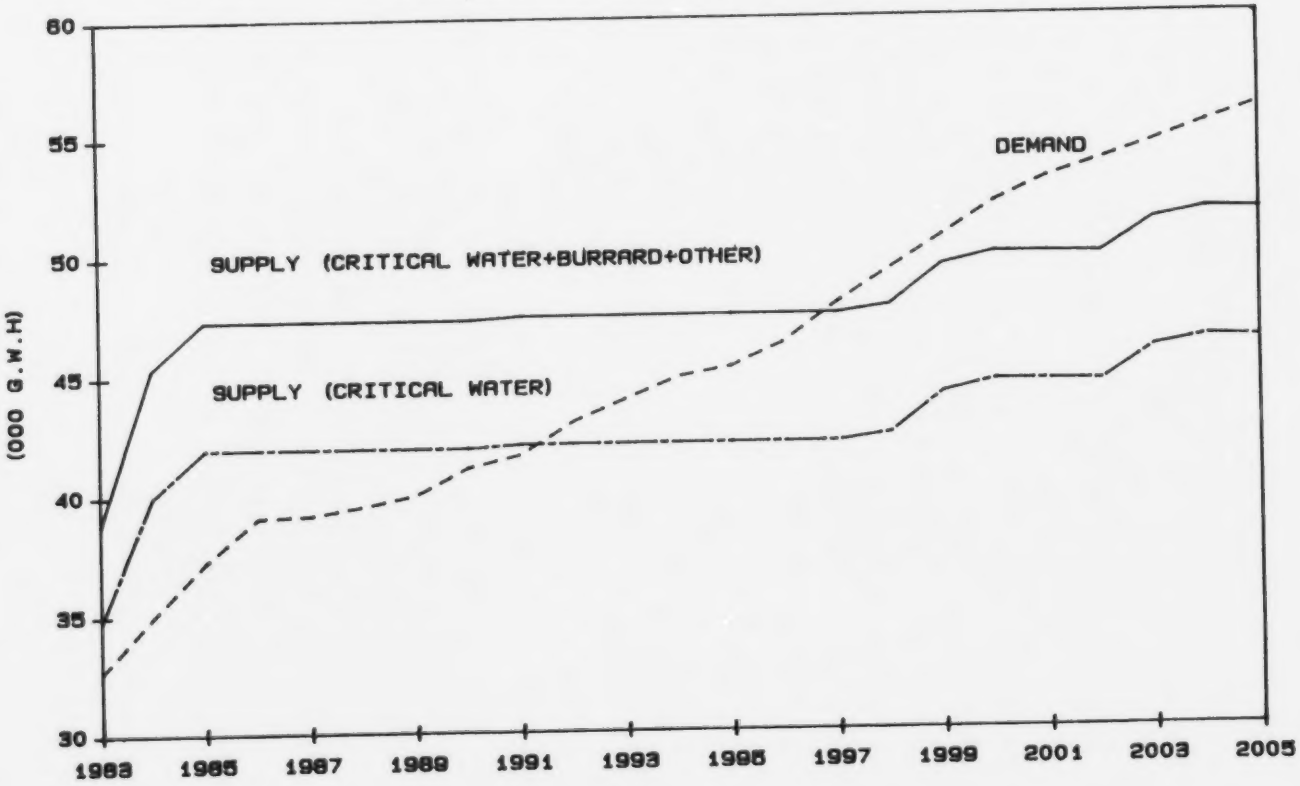


Table 10.2

B.C. Hydro System Supply/Demand Balance
(GWh)

Year	Requirements[1]	Firm Capability	Supply/Demand Balance (deficit)
1984(act.)	35,018	45,355	10,337
1985(est.)	37,243	47,320	10,077
1986	39,082	47,320	8,238
1987	39,172	47,320	8,148
1988	39,537	47,320	7,783
1989	39,995	47,320	7,325
1990	41,131	47,320	6,189
1991	41,661	47,470	5,809
1992	43,030	47,470	4,440
1993	43,963	47,470	3,507
1994	44,859	47,470	2,611
1995	45,275	47,470	2,195
1996	46,266	47,470	1,204
1997	47,893	47,470	(423)
1998	49,283	47,785	(1,498)
1999	50,676	49,470	(1,206)
2000	52,078	49,960	(2,118)
2001	53,093	49,920	(3,173)
2002	53,781	49,880	(3,901)
2003	54,530	51,300	(3,230)
2004	55,335	51,720	(3,615)
2005	56,079	51,648	(4,431)
AAR			
1984-2005	2.3	0.6	--

1 Includes WKPL deficit, and purchased electricity requirements only.

10.2 Natural Gas

Unlike the supply and demand comparisons presented for other fuels in this chapter, the supply/demand balance for natural gas is determined using procedures developed specifically for evaluating the natural gas surplus in the province.

In 1982, a Commissioner Inquiry[1] developed criteria for determining the existence and extent of the province's natural gas surplus, and for estimating the volume of natural gas which could reasonably be allocated to export and to new industrial projects. These criteria encompass two tests - a Producibility Test and an Extended Reserves Test.

The October 31, 1985 "Agreement Among the Governments of Canada, Alberta, British Columbia and Saskatchewan on Natural Gas Markets and Prices" committed the province to a review of its gas surplus determination procedures. Although this review is currently underway, the supply/demand balance reported in this section is based on the procedures recommended by the Inquiry in 1982.

The full producibility of natural gas shown in Table 10.3 refers to the supply of marketable gas from domestic and extra-provincial sources. Domestic supply includes supplies

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1 "Commissioner Inquiry on British Columbia's Requirements, Supply and Surplus of Natural Gas and Natural Gas Liquids," George W. Govier, Commissioner, Victoria, May 1982.

TABLE 10.3

PRODUCIBILITY TEST

(PETAJOULES)

YEAR	FULL PRODUCIBILITY	DOMESTIC REQUIREMENTS	EXISTING EXPORTS	HYPOTHETICAL PROJECT	TOTAL DEMAND	PRODUCTION	DEFICIT	ADJUSTED PRODUCIBILITY
1985	551.62	202.47	101.66	.00	304.13	304.13	.00	551.62
1986	555.90	196.36	101.32	1.41	299.10	299.10	.00	565.80
1987	538.33	204.89	104.66	8.35	317.90	317.90	.00	564.73
1988	534.43	219.89	113.57	8.35	341.81	341.81	.00	575.67
1989	557.95	230.77	121.36	8.35	360.47	360.47	.00	610.93
1990	524.11	239.47	124.70	8.35	372.52	372.52	.00	586.41
1991	508.51	250.06	128.71	8.35	387.11	387.11	.00	576.37
1992	493.79	256.30	132.72	8.35	397.36	397.36	.00	565.71
1993	505.31	261.76	136.73	8.35	406.83	406.83	.00	579.91
1994	499.70	265.47	140.73	8.35	414.55	414.55	.00	576.37
1995	484.27	265.70	144.74	8.35	418.79	418.79	.00	573.37
1996	477.81	267.52	147.86	8.35	423.72	423.72	.00	576.97
1997	466.64	271.10	150.98	8.35	430.42	430.42	.00	575.29
1998	454.88	274.55	154.10	8.35	436.99	436.99	.00	573.80
1999	442.34	277.18	157.21	8.35	442.74	442.74	.00	575.62
2000	430.32	279.14	160.33	8.35	447.82	447.82	.00	575.18
2001	420.23	276.59	163.67	6.95	447.21	447.21	.00	571.64
2002	411.71	276.41	167.01	.00	443.42	443.42	.00	565.68
2003	401.44	277.23	170.35	.00	447.58	447.58	.00	555.20
2004	394.90	279.26	173.69	.00	452.95	452.95	.00	546.26
2005	391.84	281.74	177.03	.00	458.77	458.77	.00	539.85

from presently connected and unconnected established gas reserves in British Columbia plus additional supplies from reserve additions and appreciations.

The extra-provincial sources reported here constitute supplies from the Yukon and Northwest Territories and from northwestern and southwestern Alberta gas fields. The supplies to northeastern British Columbia include natural gas contracted to Westcoast Transmission Company by AMOCO, Pan-Alberta, and other Alberta producers for export to the United States. The southeastern British Columbia supplies from Alberta are purchased to meet the provincial domestic requirements in adjacent British Columbia areas.

The total supply of natural gas available to the province is expected to decline from 551.6 PJ in 1985 to 391.8 PJ in 2005 (see Table 10.3). This decline is due to the dwindling volumes of gas contracted from extra-provincial sources and the projected drop in natural gas supplies from connected and unconnected reserves. Part of this decline will be offset by gas from future reserves additions.

Domestic demand for natural gas, is forecast to increase from 202.5 PJ in 1985 to 281.7 PJ in 2005. The total demand, however, increases from 304.1 PJ in 1985 to 458.8 PJ in 2005.

The comparison between annual supply and demand presented in Table 10.3 indicates that the rate of gas supply (full producibility) far exceeds the demand until 1999. However, the gas that was not produced in the pre-1999 period can be carried forward to augment supply. "Adjusted Producibility" is the potential supply that can be available to the province. Comparing adjusted producibility and total demand

suggests that the province can readily meet its domestic and current export commitments on an annual basis over the entire forecast period.

10.2.1 Surplus of Marketable Natural Gas

The gas surplus has been estimated using the Extended Reserves Test for each year starting in 1985 through to 2005 (see Table 10.4). The test indicates a surplus of 2915 PJ in 1985, declining to 1240 PJ by 2000. The Reserves Test indicates that the province has significant volumes of gas surplus to domestic requirements and current export commitments.

10.3 Total Liquid Hydrocarbons

Total liquid hydrocarbon requirements are defined to include end-use and non-energy demand for all refined petroleum products (heavy fuel oil, diesel, light fuel oil, stove oil, kerosene, motor gasoline, aviation gasoline, aviation turbo fuel and liquefied petroleum gases), plus refinery own-use requirements. A forecast of liquid hydrocarbon supply (crude oil and natural gas liquids) was provided by the Petroleum Resources Division of the Ministry. Tables 10.5 and 10.6 report the supply/requirements balance in cubic metres and petajoules respectively.

As illustrated in these two tables, the province will continue its deficit position and to rely on increased interprovincial transfers of crude oil and refined petroleum products. The deficit has increased due to a delay in supply from the Desan oil field and because of the exclusion of supplies resulting from tertiary recovery operations.

TABLE 10.4

EXTENDED RESERVES TEST FORECAST OF TOTAL SURPLUS

(PETAJOULES)

YEAR	REMAINING ESTABLISHED RESERVES	REMAINING EXTRA-PROVL RESERVES	TOTAL RESERVES	FORECAST MAINLAND REQUIREMENTS	25A(I) (I=1,..24)	FFR ALLOWANCE	REMAINING EXPORT COMMITMENTS	TOTAL REQUIREMENTS ALLOWANCE	TOTAL SURPLUS
1985	9243.18	515.19	9758.37	202.47	5061.65	413.99	1367.69	6843.33	2915.04
1986	9149.86	433.19	9583.05	195.35	4883.84	435.88	1389.80	6709.52	2873.53
1987	8853.03	328.13	9181.16	200.87	5021.87	457.76	1054.95	6534.58	2646.58
1988	8536.90	228.93	8765.83	206.01	5150.37	475.62	717.97	6343.96	2421.87
1989	8260.98	136.11	8397.09	213.60	5339.97	493.49	380.98	6214.44	2182.65
1990	8075.51	56.33	8131.84	219.62	5490.52	511.35	98.77	6100.64	2031.20
1991	8089.67	38.55	8128.23	228.87	5721.77	529.21	90.42	6341.41	1786.82
1992	8088.61	21.94	8110.56	234.41	5860.30	547.08	82.07	6489.45	1621.11
1993	8074.66	8.56	8083.22	238.73	5968.30	575.75	73.73	6617.78	1465.44
1994	8042.38	4.67	8047.05	241.10	6027.52	609.15	65.38	6702.06	1344.99
1995	8001.89	1.95	8003.84	239.95	5998.70	643.88	57.03	6699.61	1304.23
1996	8069.56	.00	8069.56	241.01	6025.25	662.68	48.69	6736.61	1332.95
1997	8126.26	.00	8126.26	243.71	6092.65	684.78	40.34	6817.77	1308.49
1998	8172.30	.00	8172.30	246.44	6160.97	702.73	31.99	6895.69	1276.60
1999	8207.97	.00	8207.97	248.34	6208.47	720.95	23.65	6953.07	1254.90
2000	8234.25	.00	8234.25	249.56	6238.95	739.50	15.30	6993.75	1240.49
2001	8352.21	.00	8352.21	246.43	6160.85	753.88	6.95	6921.68	1430.53
2002	8462.66	.00	8462.66	245.62	6140.50	769.73	.00	6910.23	1552.44
2003	8569.12	.00	8569.12	245.78	6144.55	786.05	.00	6930.60	1638.52
2004	8663.96	.00	8663.96	247.14	6178.52	802.83	.00	6981.35	1682.61
2005	8746.26	.00	8746.26	248.99	6224.77	818.63	.00	7043.40	1702.86

FFR: FIRM FUTURE REQUIREMENTS

TABLE 10.3

SUPPLY/DEMAND BALANCE
FOR LIQUID HYDROCARBONS

(000 CUBIC METRES)

YEAR	DOMESTIC REQUIREMENTS			DOMESTIC SUPPLY‡‡	SUPPLY/DEMAND BALANCE
	NON-MOTIVE‡	MOTIVE	TOTAL		
1981	3915.5	7166.1	11081.6	2361.7	-8719.9
1982	3309.2	6688.8	9998.0	2409.2	-7588.8
1983	3125.8	5778.3	8904.2	2353.9	-6550.3
1984	3176.2	5675.4	8851.6	2400.5	-6451.1
1985	3259.7	5873.0	9132.7	3000.2	-6132.5
1986	3336.8	6278.9	9615.8	2837.0	-6778.8
1987	3442.8	6281.1	9723.9	2649.5	-7074.4
1988	3305.5	6368.5	9674.0	2434.6	-7239.4
1989	3316.1	6373.3	9689.4	2251.1	-7438.3
1990	3323.4	6411.4	9734.8	2094.7	-7640.1
1991	3368.4	6469.5	9837.9	1969.5	-7868.4
1992	3400.3	6593.4	9993.8	1880.7	-8113.1
1993	3470.6	6726.3	10197.0	1803.3	-8393.7
1994	3519.5	6861.5	10381.0	1831.7	-8549.3
1995	3578.0	6974.2	10552.2	1837.5	-8714.7
1996	3723.7	7082.4	10806.1	1875.9	-8930.2
1997	3880.2	7194.5	11074.8	1861.9	-9212.9
1998	3978.3	7298.1	11276.5	1868.4	-9408.1
1999	4172.3	7439.9	11612.2	1856.0	-9756.2
2000	4277.7	7567.5	11845.1	1834.4	-10010.7
2001	4385.4	7694.2	12079.6	1815.7	-10263.9
2002	4489.3	7804.7	12294.0	1798.8	-10495.2
2003	4624.4	7908.4	12532.8	1781.4	-10751.4
2004	4692.4	8004.3	12696.7	1747.3	-10949.4
2005	4749.9	8077.3	12827.2	1729.2	-11098.0

‡ INCLUDES NON-ENERGY USE

‡‡ DOMESTIC SUPPLY INCLUDES NATURAL GAS LIQUIDS

TABLE 10.6

SUPPLY/DEMAND BALANCE
FOR LIQUID HYDROCARBONS

(PETAJOULES)

YEAR	DOMESTIC REQUIREMENTS			DOMESTIC SUPPLY‡‡	SUPPLY/DEMAND BALANCE
	NON-MOTIVE‡	MOTIVE	TOTAL		
1981	153.4	259.7	413.2	89.3	-323.9
1982	129.1	242.5	371.5	91.0	-280.5
1983	121.7	206.7	328.5	89.1	-239.4
1984	124.1	202.6	326.7	90.9	-235.8
1985	127.3	209.3	336.7	106.4	-230.2
1986	130.4	224.1	354.5	101.5	-253.0
1987	134.5	224.6	359.1	94.9	-264.1
1988	129.1	228.2	357.3	87.1	-270.2
1989	129.5	228.5	358.0	80.3	-277.7
1990	129.9	230.0	359.8	74.4	-285.4
1991	131.7	232.0	363.7	69.7	-294.1
1992	133.0	236.4	369.4	66.1	-303.3
1993	135.7	241.2	376.8	63.0	-313.8
1994	137.5	246.0	383.5	63.8	-319.7
1995	139.5	250.2	389.7	63.6	-326.1
1996	145.1	254.1	399.2	64.6	-334.6
1997	151.1	258.3	409.3	63.9	-345.4
1998	154.7	262.1	416.8	64.0	-352.8
1999	162.4	267.2	429.6	63.4	-366.3
2000	166.3	271.9	438.2	62.4	-375.7
2001	170.4	276.5	446.9	61.5	-385.4
2002	174.4	280.5	454.8	60.6	-394.2
2003	179.6	284.2	463.8	59.7	-404.0
2004	182.2	287.7	469.8	58.3	-411.5
2005	184.4	290.3	474.7	57.5	-417.2

‡ INCLUDES NON-ENERGY USE

‡‡ DOMESTIC SUPPLY INCLUDES NATURAL GAS LIQUIDS

10.4 Heavy Fuel Oil

The requirements for heavy fuel oil, as summarized in Table 8.6 of Chapter 8, are brought together with refinery own use, losses, etc. and the supply of heavy fuel oil as outlined in Table 9.4 of Chapter 9. These are presented below in both cubic metres (Table 10.7) and petajoules (Table 10.8).

Comparison of supply and demand forecasts indicate that a shortfall of heavy fuel oil is expected throughout the forecast period. The shortfall is expected to be supplied from either inter-provincial transfers or imports from outside Canada.

The supply and demand of heavy fuel oil is pivotal in determining the volume of natural gas which will be consumed by the pulp and paper mills on Vancouver Island.[2] As outlined in the Natural Gas Supply to Vancouver Island Technical Report, a surplus of domestic production of heavy fuel oil would result in price discounting with the result that natural gas (in the absence of firm contracts) would be backed out until the excess supply had been dissipated.

British Columbia refineries have instituted measures to reduce production of heavy fuel oil per barrel of throughput. These measures have already caused a significant drop in the heavy fuel oil yield (i.e. heavy fuel oil production as a proportion of total throughput) from 11.1 percent in 1981 to 8.5 percent in 1984. Over the

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2 For the purposes of this forecast, the southern route of the Vancouver Island gas pipeline as detailed in the Abercrombie report (Natural Gas supply to Vancouver Island; Technical Report. MEMPR, April, 1983.) has been assumed, which indicates that natural gas service will be available to Crofton, Elk Falls, Harmac and Port Alberni.

TABLE 10.7

SUPPLY/DEMAND BALANCE
FOR HEAVY FUEL OIL

(000 CUBIC METRES)

YEAR	TOTAL REQUIREMENTS§	B,C, HFO PRODUCTION	SUPPLY/DEMAND BALANCE
1981	1548.1	983.1	-565.0
1982	1295.7	893.5	-402.2
1983	903.0	719.1	-183.9
1984	827.0	645.8	-181.1
1985	849.2	587.1	-262.1
1986	870.3	619.3	-251.0
1987	926.0	620.3	-305.7
1988	869.0	621.0	-248.0
1989	875.0	603.8	-271.2
1990	884.2	605.9	-278.3
1991	899.4	606.4	-293.0
1992	902.3	606.0	-296.3
1993	912.9	605.8	-307.1
1994	921.0	557.4	-363.6
1995	935.3	383.2	-552.1
1996	949.8	401.6	-548.1
1997	982.5	403.0	-579.4
1998	992.0	403.1	-588.9
1999	1001.9	402.8	-599.1
2000	1011.4	402.9	-608.6
2001	1034.9	402.8	-632.1
2002	1049.7	402.8	-647.0
2003	1060.6	402.5	-658.1
2004	1064.5	402.9	-661.6
2005	1067.6	403.0	-664.6

§ PRIMARY REQUIREMENTS

TABLE 10.8

SUPPLY/DEMAND BALANCE
FOR HEAVY FUEL OIL

(PETAJOULES)

YEAR	TOTAL REQUIREMENTS$_1$	D,C, HFO PRODUCTION	SUPPLY/DEMAND BALANCE
1981	64.6	41.0	-23.6
1982	54.1	37.3	-16.8
1983	37.7	30.0	-7.7
1984	34.5	27.0	-7.6
1985	35.4	24.5	-10.9
1986	36.3	25.8	-10.5
1987	38.6	25.9	-12.8
1988	36.3	25.9	-10.4
1989	36.5	25.2	-11.3
1990	36.9	25.3	-11.6
1991	37.5	25.3	-12.2
1992	37.7	25.3	-12.4
1993	38.1	25.3	-12.8
1994	38.4	23.3	-15.2
1995	39.0	16.0	-23.0
1996	39.6	16.8	-22.9
1997	41.0	16.8	-24.2
1998	41.4	16.8	-24.6
1999	41.8	16.8	-25.0
2000	42.2	16.8	-25.4
2001	43.2	16.8	-26.4
2002	43.8	16.8	-27.0
2003	44.3	16.8	-27.5
2004	44.4	16.8	-27.6
2005	44.6	16.8	-27.7

1 PRIMARY REQUIREMENTS

entire forecast period this yield will be 7.7 percent. Moreover the closure of a refinery in 1995 is projected to cause a significant drop in the throughput and hence in the supply of heavy fuel oil.

10.5 Hog Fuel

Table 10.9 presents the hog fuel supply demand balance determined from the analysis presented in Chapter 5. The forecast of supply is based on the methodology outlined in sections 5.1.1 and 5.1.2. Hog fuel demand includes the needs of both the wood products industry and the pulp and paper mills. Where insufficient supplies of hog fuel are available on a regional basis, the quantity consumed by mills is constrained.

TABLE 10.9

HOG FUEL SUPPLY AND DEMAND BALANCE

(PETAJOULES)

	DEMAND			SUPPLY			BALANCE		
YEAR	S. COAST	N. COAST	INTERIOR	S. COAST	N. COAST	INTERIOR	S. COAST	N. COAST	INTERIOR
1984	40.7	4.0	26.8	51.3	11.7	95.3	10.5	7.7	68.5
1985	44.7	4.4	30.5	53.2	12.1	103.9	8.5	7.7	73.4
1986	46.3	4.7	34.0	52.0	11.8	106.3	5.7	7.1	72.3
1987	50.4	4.8	34.4	50.4	12.4	107.7	.0	7.6	73.3
1988	48.0	4.9	35.0	49.4	12.3	106.8	1.4	7.4	71.8
1989	47.3	4.9	35.6	48.9	12.8	106.0	1.6	7.8	70.3
1990	47.5	5.0	35.2	49.6	12.4	105.2	2.1	7.4	70.0
1991	47.5	5.1	36.4	50.2	11.8	104.0	2.7	6.6	67.6
1992	47.2	5.2	36.4	50.4	11.5	103.9	3.2	6.2	67.4
1993	46.9	5.3	37.7	50.5	11.7	103.4	3.6	6.4	65.7
1994	46.8	5.4	38.0	50.5	11.8	103.2	3.7	6.5	65.2
1995	46.6	5.4	38.3	50.5	12.0	103.1	3.9	6.6	64.8
1996	49.9	5.4	38.4	51.4	11.9	103.0	1.5	6.5	64.6
1997	47.6	5.4	38.4	51.9	12.1	102.9	4.3	6.7	64.5
1998	47.7	5.3	38.5	52.5	12.2	102.9	4.8	6.9	64.4
1999	47.7	5.3	38.4	53.0	12.4	102.8	5.3	7.1	64.3
2000	47.8	5.3	38.4	53.6	12.6	102.7	5.8	7.3	64.3
2001	47.8	5.3	40.4	53.9	13.0	102.6	6.1	7.8	62.2
2002	47.8	5.2	40.4	53.9	13.7	102.5	6.1	8.5	62.1
2003	47.8	5.2	40.4	53.9	14.5	102.5	6.1	9.2	62.0
2004	47.8	5.2	40.5	54.0	15.2	102.4	6.2	10.0	61.9
2005	47.8	5.2	40.7	57.6	16.0	102.0	9.9	10.8	61.3

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